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14. ABSTRACT
SPX was the tenth in the series of international conferences on Stochastic Programming (SP). The first was held on the campus of Oxford University 30 years ago. Since then, the series of conferences has crossed the Atlantic Ocean several times (the last two meetings in North America were held in Ann Arbor MI (1989) and Vancouver BC (1995). Stochastic programming has emerged as one of the leading modeling paradigms for decision-making under uncertainty, and the current surge in interest in SP was reflected in the attendance at SPX. With representation from more than 25 nations, including students and faculty from a world-wide selection of universities, the conference was attended by more than 200 participants.

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Final Report

SPX: The Tenth International Conference on Stochastic Programming

University of Arizona

Tucson, AZ

October 2004

SPX was the tenth in the series of international conferences on Stochastic Programming (SP). The first was held on the campus of Oxford University 30 years ago. Since then, the series of conferences has crossed the Atlantic Ocean several times (the last two meetings in North America were held in Ann Arbor MI (1989) and Vancouver BC (1995)). Stochastic Programming has emerged as one of the leading modeling paradigms for decision-making under uncertainty, and the current surge in interest in SP was reflected in the attendance at SPX. With representation from more than 25 nations, including students and faculty from a world-wide selection of universities, the conference was attended by more than 200 participants.

Meeting Highlights:

In keeping with the traditions of this conference series, invitations to keynote and plenary speakers were extended to individuals based on input from the international program committee, whose membership appears in Appendix I of this report. It is also the tradition of this series to not identify other sessions as "invited."

Roger J-B. Wets and R. Tyrrell Rockafellar delivered keynote addresses at the conference. Their individual and joint research programs have been instrumental in pushing the frontiers of stochastic programming in theory, algorithms, and applications. These two visionary speakers set the tone for the rest of the meeting. Their presentations were entitled "Making Stochastic Programming User-Friendly" (Wets) and "Risk Measures and Safeguarding in Stochastic Optimization" (Rockafellar).

Warren Powell (Princeton University), Werner Römisch (Humboldt University, Berlin Germany), Nikolaos Sahinidis (University of Illinois, Urbana-Champaign), and Teemu Pennanen (Helsinki School of Economics, Finland) delivered the plenary addresses. Their presentations were entitled "Missing Data, Noises and Lies: The Evolving Discovery of Misinformation in the Management of Boxcars in Rail Transportation" (Powell), "Scenario Modelling for Multi-Stage Stochastic Programming" (Römisch), "Stochastic Integer Programming: Algorithms and Applications" (Sahinidis), and "An Analytical Approach to Stochastic Programming" (Pennanen).

The conference included nearly 200 presentations in technical sessions organized into 15 sessions with three parallel tracks each. Prominent themes in the conference serve as indicators of emerging paths within the discipline, and include Stochastic Integer Programming and a broad range of Applications of Stochastic Programming.

Given that it was the tenth in the conference series, SPX was something of a landmark for the SP community. Accordingly, a special session was convened during which we paid tribute to the field's "pioneers" – those individuals whose insight and dedication 25-30 years ago ultimately provided the foundation on which the discipline is built. The individuals who were honored are:

George B. Dantzig	(Stanford Univ., USA)
Michael A.H. Dempster	(Cambridge Univ., England)
Jitka Dupaçová	(Charles Univ., Czech Repulic)
Yuri Ermoliev	(International Inst. for Applied Systems Analysis, Austria)
Peter Kall	(University of Zürich, Switzerland))
Willem K. Klein Haneveld	(Univ. of Groenigen, Netherlands)
Kurt Marti	(Federal Armed Forces Univ., Germany)
Andras Prékopa	(Rutgers Univ., USA)
Stephen M.Robinson	(Univ. of Wisconsin, USA)
R. Tyrell Rockafellar	(Univ. of Washington, USA)
Roger J-B Wets	(Univ. of California – Davis, USA
William T. Ziemba	(Univ. of British Columbia – Canada)

Sample posters highlighting the contributions of George B. Dantzig and Stephen M. Robinson are included in the Appendix II of this report, and can be found at www.stoprog.org/Pioneers/Pioneers.html.

Student Program

Several features of the conference were designed to attract graduate students and facilitate their participation in the conference activities. The most prominent of these was the NSF-sponsored tutorial program. The tutorial program, chaired by David Morton (Univ. of Texas, Austin), was held during the weekend immediately preceding the conference and was designed to help interested graduate students familiarize themselves with this new and powerful discipline. Seven 90-minute tutorials were presented by leading researchers in the field. More than fifty graduate students from 25 universities attended these tutorials. The tutorial speakers were:

1. Andy Philpott (Univ. of Auckland, New Zealand) "Introduction to Modelling using Stochastic Programming"
2. Maarten H. van der Vlerk (Univ. of Groningen, Netherlands), "Introduction to algorithms for recourse models"
3. Shabbir Ahmed (Georgia Inst. of Technology, USA) "Stochastic integer programming: An algorithmic perspective"
4. Rene Henrion (Wierstrass Institute, Germany), "Optimization Problems with Probabilistic Constraints"
5. Georg Pflug (Univ. of Vienna, Austria), "Scenario Estimation and Scenario Generation"
6. Pavel Popela (Brno Univ. of Technology, Czech Republic), "Stochastic Programming Applications"
7. Gautam Mitra (Brunel University, England), "Software Tools for Stochastic Programming (Asset and Liability Management Model)"

Copies of these presentations have been made publicly available through the Stochastic Programming Community website, www.stoprog.org/resources.html. Funds to assist with travel expenses for twenty students attending the tutorial program were provided by

NSF. Students receiving these awards were nominated by faculty in their home departments, and ultimately selected by the tutorial chair (Dave Morton, Univ. of Texas, Austin). These students came from Brunel Univ. (England), Univ. of Florida, Montreal Polytechnic School, Princeton Univ., Budapest Univ. of Technology and Economics, Texas A&M Univ., Univ. of Pittsburgh, to name but a few. All students were offered a substantially reduced conference registration rate ($295 for non-student attendees, and $40 for student attendees). In addition, donations from conference attendees made it possible for students to attend the social program (especially the conference banquet, which was held at the Arizona-Sonora Desert Museum) at no additional charge to the student. We are pleased to note that nearly every student who attended the tutorial program stayed in Tucson to attend the conference as well. We are also pleased to note that the tutorial program attracted a significant number of non-students as well. Several industrial attendees and university faculty with an interest in learning some of the "basics" of stochastic programming attended the tutorial program as well.

Appendix I: Program Committee Membership

John R. Birge	(Northwestern University, U. S. A.)
Darinka Dentcheva	(Stevens Institute of Technology, U. S. A.)
Alexei Gaivoronski	(Norwegian University of Science and Technology, Norway)
Gus Gassmann	(Dalhousie University, Canada)
Alan King	(IBM, U. S. A.)
Janos Mayer	(University of Zurich, Switzerland)
Gautam Mitra	(Brunel University, U. K.)
Georg Pflug	(University of Vienna, Austria)
Andy Philpott	(Auckland University, New Zealand)
Warren Powell	(Princeton University, U. S. A.)
Stephen M. Robinson	(University of Wisconsin - Madison, U. S. A.)
R. Tyrrell Rockafellar	(University of Washington, U. S. A.)
Werner Roemisch	(Humboldt-University Berlin, Germany)
Andrzej Ruszczynski	(Rutgers University, U. S. A.)
Ruediger Schultz	(Gerhard Mercator University, Germany)
Stanislav Uryasev	(University of Florida, U. S. A.)
Maarten van der Vlerk	(University of Groningen, Netherlands)
Stein W. Wallace	(Molde University College, Norway)
Roger J-B Wets	(University of California - Davis, U. S. A)
David Woodruff	(University of California - Davis, U. S. A.)
William Ziemba	(University of British Columbia, Canada)

Appendix II: Sample "Pioneer" Posters

George B. Dantzig
Stanford University, U.S.A

A member of the National Academy of Engineering, the National Academy of Science, the American Academcy of Arts and Sciences, and recipient of the National Medal of Science, plus eight honorary degrees, Professor Dantzig's seminal work has laid the foundation for much of the field of systems engineering and is widely used in network design and component design in computer, mechanical, electrical engineering - Stanford University Citation

George B. Dantzig is well known as the father of linear programming. This "underestimates his paternal accomplishments" as is compellingly illustrated in Richard Cottle's recent book *The Basic George B. Dantzig.*

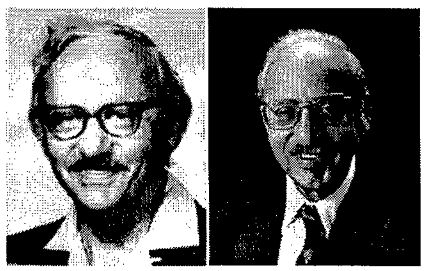
From the time linear programming was discovered, Dantzig recognized that the "real problem" concerned programming under uncertainty. Dantzig's vision in his early papers is truly remarkable. His 1955 paper, which introduced linear programming under uncertainty, fully presents the simple recourse model, the two-stage stochastic linear program with recourse and the multi-stage stochastic linear program with recourse.

His 1961 paper (with A. Madansky) on applying the decomposition principle to solve two-stage stochastic linear programs recognizes connections to Kelley's cutting-plane algorithm and precedes Benders decomposition and the well-known L-Shaped method of Van Slyke and Wets. The 1961 paper concludes with the remark, "An interesting area of future consideration is the effect of sampling the distribution'" to statistically estimate cut gradients and intercepts. Three decades later, such methods were developed by Dantzig, Glynn & Infanger and by Higle & Sen.

Dantzig's discoveries were continually motivated by applications. As he tells it, the decomposition principle (with P. Wolfe) was largely developed on a plane flight from Texas back home to Santa Monica after visiting an oil company and initially miscalculating the size of their linear program. In 1956, he extended earlier work (with A.R. Ferguson) on an aircraft allocation problem to include uncertain customer demand. Dantzig has said that he fails to see the difference between the so-called pure and non-pure mathematics and doesn't believe there is any. He further said, "Just because my mathematics has its origin in a real problem doesn't make it less interesting to me---just the other way around." The first sentence in Dantzig's 1963 textbook is, "The final test of a theory is its capacity to solve the problems which originated it." A survey of the lectures at The Tenth International Conference on Stochastic Programming shows that stochastic programming's capacity is strong and is growing. This is a fitting tribute to the father of stochastic programming.

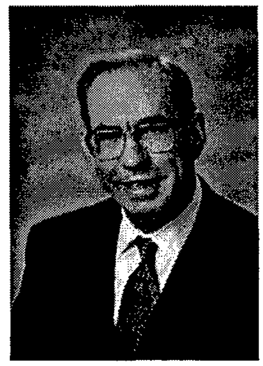
Selected Contributions

- "Linear programming under uncertainty,"*Management Science* (1955).
- "The allocation of aircraft to routes: an example of linear programming under uncertain demand (with A.R. Ferguson)," *Management Science* (1956).
- "On the solution of two-stage linear programs under uncertainty," (with A. Madansky).in *Proceedings of the Fourth Berkeley Symposium on Mathematical Statistics and Probability*, J. Neyman (ed.), University of California Press, Berkeley, (1961).
- *Linear Programming and Extensions,* Princeton University Press (1963).
- "Time-staged methods in linear programs," in *Large-Scale Systems*, Studies in Management Science, Vol. 7, Y.Y. Haims (ed.), North-Holland, Amsterdam (1982).
- "Parallel processors for planning under uncertainty," (with P.W. Glynn). *Annals of Operations Research* (1990).
- Large-scale stochastic linear programs: importance sampling and Benders' decomposition(with G. Infanger) in Proceedings of the 13th IMCAS World Congress, C. Brezinski and U. Kulisch (eds.), Dublin, Ireland (1991).



Stephen M. Robinson

University of Wisconsin
USA



Steve Robinson has had a long and abiding interest in numerical methods for optimization. His contributions to the study of error bounds under data perturbations, and continuity of solution sets under data perturbations have deep implications for stochastic programming problems, and led to his joint work with Roger Wets on stability of two-stage stochastic programs. More recently, Steve has worked on sample path optimization, and applied these methods to decision models arising in manufacturing and military applications. Among his most important practical contributions, Steve has championed the use ofstochastic programming in the U.S Department of Defense. His joint paper with Laferriere, which appeared in *Phalanx*, was awarded the 2001 John K. Walker Award in Military OR by that community within INFORMS.

Steve's academic accomplishments have earned him several awards, including the Dantzig Award from SIAM/MPS in 1997, and an honorary doctorate from the University of Zurich, Switzerland.

Steve Robinson has played a leadership role in a variety of arenas. He has served as the Editor of *Math. of Operations Research*, and the Secretary of INFORMS. Steve is a highly decorated veteran and retired as a Colonel in the U.S. Army.

Selected Contributions

- "Bounds for error in the solution set of a perturbed linear program," *Linear Alg. Appl.* (1973)
- "Computable error bounds for nonlinear programming," *Math. Prog.* (1973)
- "A characterization of stability in linear programming," *Oper. Res.* (1977)
- "Stability in two-stage stochastic programming," (with Roger Wets), *SIAM J. on Control and Opt.* (1987)
- "Analysis of Sample-path Optimization," *Math. of Oper. Res.* (1996)
- "Scenario analysis in U.S. Army decision-making," (with Laferriere), *Phalanx* (2000)

We gratefully acknowledge the support of the following sponsors:

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Welcome from Conference Chairs

It is our honor and privilege to welcome you to the Tenth International Conference on Stochastic Programming. With the growth of computing capacity, and the emergence of new and challenging applications, the field of Stochastic Programming has rapidly soared into visibility. The pace of algorithmic development has also kept pace with computing power, and together these advances are making it possible to address some of the most challenging problems arising under the rubric of "Decision-Making under Uncertainty." Over the next week, this conference will highlight advances in algorithms, software, and theory for Stochastic Programming, together with a variety of applications in economics, engineering, finance, transportation, and many more. With over 150 high quality presentations, this conference reflects the vibrant growth experienced by our field. We are looking forward to an intellectually stimulating week. Equally stimulating will be the special issue of *Annals of Operations Research* that will be published in association with this conference.

Stochastic Programming is finally set to deliver on the promise envisioned in George Dantzig's seminal paper (*Management Science* [1955]). Several other individuals such as Michael Dempster, Jitka Dupačová, Yuri Ermoliev, Peter Kall, Wim Klein Haneveld, Kurt Marti, Andras Prékopa, Steve Robinson, Terry Rockafellar, Roger Wets, and Bill Ziemba helped to develop this field through important publications and conferences in the 1960's and 70's. At this, the tenth conference, we will honor these pioneers for setting the stage for the surge that Stochastic Programming is experiencing today. This ceremony is scheduled for an hour-long session on Wednesday morning, October 13, 2004.

We'd like to thank our sponsors, especially the Air Force Office of Scientific Research (AFOSR), and Lt. Col. Juan Vasquez. Juan's confidence in this endeavor was instrumental in getting us started. We also thank the members of the program committee, who were instrumental in several decisions. In addition, we'd like to thank others whose efforts helped to shape the program: Tapas Das, Gerd Infanger, Victor de Miguel, John Mulvey, R. Ravi, Hanif Sherali, and Pascal Van Hentenryk. Locally, the staffs associated with the MORE Institute, the SIE Department, and the University of Arizona in general, have made it possible to organize this meeting. Vineet Agarwal, Danielle Gibboni, Michael Krotchie, and Meg Rosenquist worked diligently to keep track of all the details associated with this conference. We must thank Myra Forchione, the SIE business manager, for going the extra mile with a smile.

Finally, we owe a special "thank you" to our current COSP Chair David Morton, who really went above and beyond the call of duty with this conference! Whether on e-mail, or on the telephone, Dave was always responsive, and "on-the-ball." He is the one who made it possible to arrange to have as many student participants as we have at this conference.

Finally, in addition to the scientific program, we have arranged some social events, and other activities, such as tennis, golf, and a self-guided tour of the Arizona-Sonora Desert Museum. If you have not signed up for some of these activities, we encourage you to do so; you will find the activity, and the company to be fun. We hope that you will find this meeting to be intellectually and socially satisfying. Have a great week!

Suvrajeet Sen,
General Chair
SPX, 2004

Julie Higle,
Program Chair
SPX, 2004

The Tenth International Conference on Stochastic Programming

SP 2004

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The Tenth International Conference on Stochastic Programming

SP 2004

MORE Institute, Systems and Industrial Engineering
University of Arizona
Tutorial Program: October 9 & 10, 2004
Main Program: October 11 - 15, 2004

Organizing Committee

*Suvrajeet Sen, General Chair
University of Arizona

*Julia L. Higle, Program Chair
University of Arizona

*David P. Morton, Tutorials Chair
University of Texas at Austin

International Program Committee

John R. Birge, Northwestern University, U. S. A.
Darinka Dentcheva, Stevens Institute of Technology, U. S. A.
Alexei Gaivoronski, Norwegian University of Science and Technology, Norway
Gus Gassmann, Dalhousie University, Canada
Alan King, IBM, U. S. A.
Janos Mayer, University of Zurich, Switzerland
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Stein W. Wallace, Molde University College, Norway
Roger J-B Wets, University of California - Davis, U. S. A
David Woodruff, University of California - Davis, U. S. A.
William Ziemba, University of British Columbia, Canada

Administrative Assistants

Vineet Agarwal, Danielle Gibboni

Webmaster

Meg Rosenquist, Vineet Agarwal

Web Programmer

Michael Krotchie

* Award subcommittee

Social Program and Activities

Sunday, October 10, 18:00 - 21:00

Conference Reception: Sheraton Four Points Ballroom. Cost: Included with full registration. (Transportation will be provided from the Sheraton to the other hotels at the end of the evening. Transportation to this event is not provided.)

Wedenesday, October 13

Activities: All activities are scheduled for the afternoon of August 13. The cost of each activity is separate from the registration fee, and should be paid at the registration desk. If you did not sign up for any activity during the online registration process, you may do so until 17:00 on Monday, October 11.

Tennis:
13:00 - 15:30. Cost: $10.00
Venue: Robson Center Tennis Courts, Univ. of Arizona.
A single elimination tournament, based on the score at the end of either 25 minutes of play or the completion of one set, whichever comes first. For the final match, players may expect to finish the set.

Golf:
12:40 - 15:30. Cost: $26.00.
Venue: Dell Urich Golf Course (this cost does not include equipment rental).
A tee-time for a group of 8, playing 9 holes of golf, has been reserved. It is recommended that those intending to play golf be ready to leave the conference site at 12:40 sharp, on a van that has been reserved for 8 golfers. Return transportation must be arranged by the participants.

Arizona-Sonora Desert Museum:
14:30 - 17:00. Cost: Included with full registrations.
The Desert Museum is a unique "museum" that highlights life in the Sonoran desert. The self-guided tour is mainly outdoors, and participants are encouraged to use sunscreen and other forms of protection from the desert sun. This is also the site of the conference banquet. (Return transportation will be provided after the banquet.)

Conference Banquet
17:00 - 22:00. Cost: Included with full registrations.
Venue: Arizona-Sonora Desert Museum
(Transportation to and from the Desert Museum will be provided. The first bus will leave the conference site at 14:30 on Wednesday, followed by additional buses at 16:00, and two more at 16:30. The buses departing at 16:30 are intended for those participating in either golf or tennis, or those who have made prior arrangements with the organizers. This will avoid a capacity crunch at 16:30.)

Daily Schedules -- "At a Glance"

Monday, October 11, 2004

MA 9:00-9:30
Grand Ballroom

- **Opening Session, with Provost George Davis, University of Arizona**

Chair: Suvrajeet Sen, University of Arizona

MB 9:30-10:30
Grand Ballroom

Keynote Address: Roger J-B Wets,University of California, Davis.
Making Stochastic Programming User-Friendly

Chair: John Birge, University of Chicago

MC 10:45-12:45

- Ballroom South: Network Interdiction
  Chair: Kevin Wood, Naval Postgradute School
- Catalina: Electricity Trading Models
  Chair: Golbon Zakeri, University of Aukland
- Rincon: Approximation Algorithms for Stochastic Combinatorial Optimization
  Chair: R. Ravi, Carnegie Mellon University

MD 13:45-15:15

- Ballroom South: Stochastic Combinatorial Optimization
  Chair: Pascal Van Hentenryk, Brown University
- Catalina: Energy Portfolio Optimization
  Chair: Stein-Erik Fleten, Norwegian Univ. of Science and Technology
- Rincon: Risk Management I
  Chair: Alexei Gaivoronski, Norwegian University of Science and Technology

ME 15:30-16:30
Grand Ballroom

Keynote Address: Terry Rockafellar,University of Washington.
Risk Measures and Safeguarding in Stochastic Optimization

Chair: John Birge, University of Chicago

MF 16:45-18:45

- Ballroom South: Risk Measures
  Chair: Stan Uryasev, University of Florida
- Catalina: Hydroelectricity Scheduling and Pool Markets
  Chair: Jens Guessow, University of St. Gallen
- Rincon: Algorithms and Approximations I
  Chair: Anton Kleywegt, Georgia Institute of Technology

Tuesday, October 12, 2004

TA 8:00-9:30

- Ballroom South: Stochastic Mixed-Integer Programming I
  Chair: Hanif Sherali, Viginia Tech
- Catalina: Stochastic Games
  Chair: Gerd Infanger, Stanford University
- Rincon: Stochastic Programming Modeling Paradigms I
  Chair: Vlasta Kankova, Academy of Sciences of the Czech Republic

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TB 9:45-10:45 Grand Ballroom
Plenary Address: Warren Powell, Princeton University
Missing Data, Noise and Lies: The Evolving Discovery of Misinformation in the Management of Boxcars in Rail Transportation.

Chair: Julia L. Higle, University of Arizona

TC 11:00-12:30

- Ballroom South: Risk Management II
  Chair: Michael Zabarankin, Stevens Institute of Technology
- Catalina: Queues, Wagering, and Auctions
  Chair: Tapas Das, University of South Florida
- Rincon: Stochastic Programming Applications I
  Chair: Arne Løkketangen, Molde University College

TD 13:30-15:00

- Ballroom South: Stochastic Integer Programming: Column Generation
  Chair: Lewis Ntaimo, Texas A&M University
- Catalina: Stochastic Programming Modeling Paradigms II
  Chair: Julia L. Higle, University of Arizona
- Rincon: Stochastic Optimization Models with Dominance Constraints
  Chair: Darinka Dentcheva, Stevens Institute of Technology

TE 15:15-16:15 Grand Ballroom
Plenary Address: Nikolaos Sahinidis, University of Illinois at Urbana-Champaign
Stochastic integer programming: algorithms and applications.

Chair: Shabbir Ahmed, Georgia Institute of Technology

TF 16:30-18:30

- Ballroom South: Stochastic Mixed Integer Programming II
  Chair: Willem K. Klein Haneveld, University of Groningen
- Catalina: Production and Inventory Models
  Chair: Alan King, IBM
- Rincon: Stochastic Programming Applications II
  Chair: Urmila Diwekar, University of Illinois at Chicago

Wednesday, October 13, 2004

WA 8:00-9:30

- Ballroom South: Enterprise Risk Management
  Chair: John Mulvey, Princeton University
- Catalina: SP Software and Modeling Systems I
  Chair: Leo Lopes, University of Arizona
- Rincon: Algorithms and Approximations II
  Chair: Cole Smith, University of Arizona

WB 9:45-10:45 Grand Ballroom

Special Session: A Salute to the Pioneers of Stochastic Programming

Chair: Bob Bixby, Chair of the Mathematical Programming Society

WC 11:00-12:30

- Ballroom South: SP Software and Modeling Systems II
  Chair: Gus Gassmann, Dalhousie University
- Catalina: Asset Liability Management
  Chair: Michael Schuerle, University of St. Gallen
- Rincon: Probabilistic Constraints
  Chair: Andras Prékopa, Rutgers University

Thursday, October 14, 2004

ThA 8:00-9:30

- Ballroom South: Portfolio Optimization
  Chair: Gerd Infanger, Stanford University
- Catalina: Scenario Generation I
  Chair: Michael Casey, University of Puget Sound
- Rincon: Statistical Methods in SP
  Chair: Jitka Dupačová, Charles University

ThB 9:45-10:45 Grand Ballroom
Plenary Address: Werner Roemisch,Humboldt-University Berlin
Scenario modelling for multistage stochastic programs.

Chair: Darinka Dentcheva, Stevens Insitute of Techology

ThC 11:00-12:30

- Ballroom South: Revenue Management
  Chair: Victor DeMiguel, London Business School
- Catalina: Scenario Generation II
  Chair: Matthias Nowak, SINTEF
- Rincon: Sensitivity Analysis
  Chair: Dave Morton, University of Texas at Austin

ThD 13:30-15:00

- Ballroom South: Stochastic Programming and Hedging
  Chair: Leonard Maclean, Dalhousie University
- Catalina: Computational Issues in Stochastic Programming
  Chair: Gus Gassmann, Dalhousie University
- Rincon: Network Design
  Chair: Stein Wallace, Molde University College

ThE 15:15-16:15 Grand Ballroom
Plenary Address: Teemu Pennanen,Helsinki School of Economics
An analytical approach to stochastic programming.

Chair: Bill Ziemba, University of British Columbia

ThF 16:30-18:30

- Ballroom South: Solution Validation
  Chair: Dave Morton, University of Texas at Austin
- Catalina: SP for Nontraditional Financial Markets
  Chair: Chanaka Edirisinghe, University of Tennessee
- Rincon: Scenario Generation III
  Chair: Paolo Brandimarte, DSPEA - Politecnico di Torino

Friday, October 15, 2004

FA 8:00-9:30

- Ballroom South: SP for Global Finance and Insurance
  Chair: Roy Kouwenberg, Asian Institute of Technology
- Catalina: Stability and Duality
  Chair: Darinka Dentcheva, Stevens Institute of Technology
- Rincon: Algorithms and Approximations III
  Chair: Shabbir Ahmed, Georgia Technological University

FB 9:45-11:45

- Ballroom South: Portfolio Optimization
  Chair: Victor DeMiguel, London Business School
- Catalina: International Finance
  Chair: Hercules Vladimirou, University of Cyprus
- Rincon: Algorithms and Approximations IV
  Chair: Huseyin Topaloglu, Cornell University

Sessions

The following pages list the presentations scheduled for each session. Only the speaker's name appears. The page on which the abstract appears follows the speaker's name. Co-author information appears with the abstract.

Monday, October 11, 2004

MB 9:30-10:30
Grand Ballroom

Keynote Address: Roger J-B Wets,University of California, Davis.
Making Stochastic Programming User-Friendly

Chair: John Birge, University of Chicago
(Abstract: p. 74)

MC 10:45-12:45

Ballroom South: Network Interdiction
Chair: Kevin Wood, Naval Postgradute School

1. A Decomposition Algorithm Applied to Planning the Interdiction of Stochastic Networks.
   Harald Held, University Duisburg-Essen. (p. 41)
2. Network Interdiction of Nuclear Material Smuggling.
   Feng Pan, Los Alamos National Laboratory. (p. 56)
3. Heuristics for Multi-stage Interdiction of Stochastic Networks.
   David Woodruff, UC Davis. (p. 75)
4. Delaying an Adversary in a Stochastic Network.
   Kevin Wood, Naval Postgraduate School. (p. 75)

Catalina: Electricity Trading Models
Chair: Golbon Zakeri, University of Aukland

1. Valuation of Electricity Swing Options by Multistage Stochastic Programming.
   Gido Haarbrücker, University of St.Gallen. (p. 40)
2. Constructing bidding curves for a price-taking electricity retailer.
   Stein-Erik Fleten, NTNU - Norwegian U of Sci and Tech. (p. 38)
3. Two-Stage Stochastic Models for Contracting Decisions of an Industrial Consumer.
   Andrés Ramos, Universidad Pontificia Comilla. (p. 60)
4. Decision Aids for Scheduling and Hedging (DASH): Computational Implications of Multi-scale Modeling.
   Suvrajeet Sen, SIE Department, University of Arizona. (p. 64)

Rincon: Approximation Algorithms for Stochastic Combinatorial Optimization
Chair: R. Ravi, Carnegie Mellon University

1. Worst-case performance analysis of polynomial time algorithms for a stochastic service provision problem.
   Leen Stougie, Technische Universiteit Eindhoven and CWI, Amsterdam. (p. 67)
2. Stochastic Network Design.
   Amitabh Sinha, University of Michigan. (p. 66)
3. An Approximation Scheme for Stochastic Linear Programming and its Application to Stochastic Integer Programs.
   Chaitanya Swamy, Cornell University. (p. 69)

MD 13:45-15:15

Ballroom South: Stochastic Combinatorial Optimization
Chair: Pascal Van Hentenryk, Brown University

1. Polyhedral Stochastic Integer Programming.
   George L. Nemhauser, Georgia Insitute of Technology. (p. 55)
2. Approximating the Stochastic Knapsack Problem: The Benefit of Adaptivity.
   Michel Goemans, MIT. (p. 39)
3. Online Stochastic Combinatorial Optimization under Time Constraints.
   Pascal Van Hentenryck, Brown University. (p. 72)

Catalina: Energy Portfolio Optimization
Chair: Stein-Erik Fleten, Norwegian Univ. of Science and Technology

1. On structuring energy contract portfolios in competitive markets.
   Antonio Alonso-Ayuso, Universidad Rey Juan Carlos. (p. 28)
2. Mean-risk optimization of electricity portfolios using polyhedral risk measures.
   Andreas Eichhorn, Humboldt-University Berlin. (p. 36)
3. Dynamic Portfolio Optimization in Electric Power Trading.
   Jens Guessow, University of St. Gallen, Institute for Operations Research and Computational Finance. (p. 40)

Rincon: Risk Management I
Chair: Alexei Gaivoronski, Norwegian University of Science and Technology

1. Algorithms for mean-risk stochastic programs.
   Wei Wang, ISyE, Georgia Tech. (p. 74)
2. Intelligent Risk Management Approach: Dynamic Risk Measures.
   George Birbilis, Brunel University, UK. (p. 31)
3. Living in the Edge: How risky is it to operate at the limit of the tolerated risk?.
   José Ramón Rodríguez-Mancilla, Sauder School of Business, University of British Columbia and Banco de México. (p. 62)

ME 15:30-16:30
Grand Ballroom

Keynote Address: Terry Rockafellar,University of Washington.
Risk Measures and Safeguarding in Stochastic Optimization

Chair: John Birge, University of Chicago
(Abstract: p. 61)

MF 16:45-18:45

Ballroom South: Risk Measures
Chair: Stan Uryasev, University of Florida

1. On Some Risk Measures in Stochastic Integer Programming.
   Stephan Tiedemann, Institute of Mathematics, University Duisburg-Essen. (p. 70)
2. General Deviation Measures and Portfolio Analysis.
   Michael Zabarankin, Dept. of Mathematical Sciences, Stevens Institute of Technology. (p. 76)
3. Risk measures as solutions of stochastic programs.
   Georg Pflug, University of Vienna. (p. 58)
4. On Deviation Measures in Stochastic Integer Programming.
   Rüdiger Schultz, Institute of Mathematics, University Duisburg-Essen. (p. 64)

Catalina: Hydroelectricity Scheduling and Pool Markets
Chair: Jens Guessow, University of St. Gallen

1. Derivation of water value distributions from multistage stochastic optimization of hydro power systems.
   Georg Ostermaier, Institute for Operations Research and Computational Finance, University of St.Gallen, Switzerland. (p. 56)
2. HERO (Hydro-electric reservoir optimization).
   Geoffrey Pritchard, University of Auckland, New Zealand. (p. 59)
3. Estimation of market distribution functions in electricity pool markets.
   Golbon Zakeri, University of Auckland. (p. 76)
4. On unit commitment in electricity pool markets.
   Andy Philpott, University of Auckland. (p. 58)

Rincon: Algorithms and Approximations I
Chair: Anton Kleywegt, Georgia Institute of Technology

1. Discretization of stochastic optimization problems with partial observations.
   Kengy Barty, CERMICS. (p. 29)
2. The sample average approximation method for multinomial probit model estimation.
   Yu-Hsin Liu, National Chi-Nan University, Taiwan. (p. 51)
3. Two-Stage Integer Programs with Stochastic Right-Hand Sides: A Superadditive Dual Approach.
   Nan Kong, University of Pittsburgh. (p. 48)
4. Derivative Free Algorithms for Stochastic Optimization.
   Anton Kleywegt, Georgia Institute of Technology. (p. 47)

Tuesday, October 12, 2004

TA 8:00-9:30

Ballroom South: Stochastic Mixed-Integer Programming I
Chair: Hanif Sherali, Viginia Tech

1. On Solving Discrete Two-Stage Stochastic Programs having Mixed-Integer First- and Second-Stage Variables.
   Xiaomei Zhu, Virginia Tech. (p. 76)
2. On Solving Stochastic Programs with Integer Recourse.
   Shabbir Ahmed, Georgia Institute of Technology. (p. 28)
3. An Algorithm for the Minimum Risk Problem with Binary First-Stage Variables.
   Cole Smith, University of Arizona. (p. 67)

Catalina: Stochastic Games
Chair: Gerd Infanger, Stanford University

1. A Stochastic Optimization- Noncooperative Game Problem: Electricity.
   Alejandro Jofre, CMM & DIM, Universidad de Chile. (p. 43)
2. A Collaborative Optimization Algorithm for Stochastic Stackelberg-Nash games.
   Kaustuv, Stanford University. (p. 46)
3. An Interior Sampling Algorithm for the Solution of Stochastic Nash Games.
   Uday V. Shanbhag, Department of Management Science and Engineering, Stanford University. (p. 65)

Rincon: Stochastic Programming Modeling Paradigms I
Chair: Vlasta Kankova, Academy of Sciences of the Czech Republic

1. Stochastic Semidefinite Programming: A Definition.
   Yuntao Zhu, Department of Mathematics, Washington State University. (p. 77)
2. A theorem on dual effect free stochastic scalar state space systems.
   Cyrille Strugarek, EDF R&D and Ecole Nationale des Ponts et Chaussées. (p. 68)
3. A Remark on Approximation and Decomposition in Multistage Stochastic Programs.
   Vlasta Kankova, Institute of Information Theory and Automation, Academy of Sciences of the Czech Republic. (p. 44)

TB 9:45-10:45
Grand Ballroom

Plenary Address: Warren Powell, Princeton University

Missing Data, Noise and Lies: The Evolving Discovery of Misinformation in the Management of Boxcars in Rail Transportation.

Chair: Julia L. Higle, University of Arizona
(Abstract: p. 59)

TC 11:00-12:30

Ballroom South: Risk Management II
Chair: Michael Zabarankin, Stevens Institute of Technology

1. Asset Liability Management modeling using multistage mixed-integer Stochastic Programming.
   Willem K Klein Haneveld, University of Groningen. (p. 47)
2. Stochastic Programming Models for Risk Budgeting.
   Alexei Gaivoronski, Norwegian University of Science and Technology. (p. 38)
3. On Risk Measures in Stochastic Programming.
   Pavlo Krokhmal, University of Florida. (p. 49)

Catalina: Queues, Wagering, and Auctions
Chair: Tapas Das, University of South Florida

1. A Quality-of-Service performance measure in queues with Poisson arrivals.
   Abhijit Gosavi, SUNY, Buffalo. (p. 39)
2. Computational Probability for High-Stakes Wagering.
   M.A. Wortman, Texas A&M University. (p. 75)
3. Performance Evaluation of Various Auction Strategies in Stochastic Energy Market Operation Games.
   Tapas Das, University of South Florida. (p. 33)

Rincon: Stochastic Programming Applications I
Chair: Arne Løkketangen, Molde University College

1. Supply Chain Management in the Natural Gas Business – A SP based application for tactical and operational trading in liberalized markets.
   Frode Rømo, SINTEF Industrial Management. (p. 62)
2. Stochastic Optimization: Rowing to Barbados.
   Geoff Leyland, University of Auckland. (p. 50)
3. Solving a Dynamic and Stochastic Vehicle Routing Problem with a Sample Scenario Hedging Heuristic.
   Arne Løkketangen, Molde University College. (p. 53)

TD 13:30-15:00

Ballroom South: Stochastic Integer Programming: Column Generation
Chair: Lewis Ntaimo, Texas A&M University

1. Solving a Stochastic Facility-Location Problem by Branch and Price.
   Eduardo Silva, Naval Postgraduate School. (p. 66)
2. Column Generation for Solving a Stochastic Capacity-Expansion Model for Electric Power Distribution.
   Kavinesh Singh, University of Auckland. (p. 66)
3. Column Generation within Stochastic Programming.
   Mehmet Demirci, University of Pittsburgh. (p. 34)

Catalina: Stochastic Programming Modeling Paradigms II
Chair: Julia L. Higle, University of Arizona

1. A Class of Stochastic Programs with Decision Dependent Uncertainty.
   Vikas Goel, Carnegie Mellon University. (p. 38)
2. Stochastic optimization using several layers of models with different levels of abstraction.
   Cem Vardar, Arizona State University. (p. 72)
3. Integrated Enterprise Modeling.
   Anne Johnson, Dept. of Systems and Industrial Engineering, University of Arizona. (p. 43)

Rincon: Stochastic Optimization Models with Dominance Constraints
Chair: Darinka Dentcheva, Stevens Institute of Technology

1. Risk-averse stochastic optimization: stochastic dominance constraints.
   Andrzej Ruszczynski, Rutgers University. (p. 62)
2. Risk-averse stochastic optimization: semi-infinite chance constraints.
   Darinka Dentcheva, Stevens Institute of Technology. (p. 35)
3. Statistical Tests for Stochastic Dominance.
   Ludmyla Rekeda, Stevens Institute of Technology. (p. 61)

TE 15:15-16:15
Grand Ballroom

Plenary Address: Nikolaos Sahinidis, University of Illinois at Urbana-Champaign

Stochastic integer programming: algorithms and applications.

Chair: Shabbir Ahmed, Georgia Institute of Technology
(Abstract: p. 63)

TF 16:30-18:30

Ballroom South: Stochastic Mixed Integer Programming II
Chair: Willem K. Klein Haneveld, University of Groningen

1. Convex approximations for mixed-integer recourse models.
   Maarten H. van der Vlerk, University of Groningen. (p. 72)
2. On the BFC approach for multistage stochastic mixed 0–1 program solving.
   Laureano Escudero, Universidad Miguel Hernández. (p. 37)
3. Disjunctive Decomposition for Stochastic Mixed-Integer Programming with Continuous First-Stage.
   Lewis Ntaimo, Dept. of Industrial Engineering, Texas A&M University. (p. 56)
4. Strong Formulations of Robust Mixed 0-1 Programming.
   Alper Atamturk, University of California at Berkeley. (p. 29)

Catalina: Production and Inventory Models
Chair: Alan King, IBM

1. Multi-item capacitated lot-sizing with demand uncertainty.
   Paolo Brandimarte, DISPEA - Politecnico di Torino. (p. 32)
2. A dual resource production planning problem under uncertainty.
   Suleyman Karabuk, University of Oklahoma. (p. 45)
3. Workforce Planning Under Uncertainty.
   Pornsarun Wirojanagud, Arizona State University. (p. 74)
4. Managing Supply Contracts for Custom Manufactured Items with Long Production Lead Times.
   Alan King, IBM Research, Yorktown Heights NJ. (p. 47)

Rincon: Stochastic Programming Applications II
Chair: Urmila Diwekar, University of Illinois at Chicago

1. A Chance-Constrained Missile-Procurement Model for Naval Surface Warfare.
   Ittai Avital, Naval Postgraduate School. (p. 29)
2. Strategic budgeting for wildfire management in the U.S..
   Gyana Parija, IBM Research. (p. 57)
3. Facility location under economics of scale in the case of uncertain demand.
   Peter Schütz, Norwegian University of Science and Technology. (p. 64)
4. Application of stochastic programming for optimal sensor placement in water distribution networks.
   Yogendra Shastri, University of Illinois, Chicago. (p. 65)

Wednesday, October 13, 2004

WA 8:00-9:30

Ballroom South: Enterprise Risk Management
Chair: John Mulvey, Princeton University

1. Dynamic Stochastic Programming in Financial Planning Applications.
   Michael A H Dempster, University of Cambridge and Cambridge Systems Associates Limited. (p. 34)
2. Integrating Financial and Operational Risks via Multi-Stage Stochastic Programming.
   John Birge, University of Chicago. (p. 31)
3. Managing Global Financial Companies via Decentralized Stochastic Programs.
   John Mulvey, Princeton University. (p. 54)

Catalina: SP Software and Modeling Systems I
Chair: Leo Lopes, University of Arizona

1. Recent developments concerning SLP–IOR.
   Janos Mayer, IOR University of Zurich. (p. 53)
2. Introducing SPInE Stochastic Extensions for the MPL Modeling System.
   Bjarni Kristjansson, Maximal Software, Inc.. (p. 49)
3. Building stochastic applications in Xpress-SP.
   Horia Tipi, Dash Optimization Inc.. (p. 70)

Rincon: Algorithms and Approximations II
Chair: Cole Smith, University of Arizona

1. Integral Stochastic Programs.
   Andrew Schaefer, University of Pittsburgh. (p. 63)
2. Global Optima Results for the Kauffman NK Model.
   Hemanshu Kaul, Dept. of Mathematics, University of Illinois at Urbana-Champaign. (p. 45)
3. Algorithms for the solution of large-scale quadratic programming (QP) models.
   Frank Ellison, CARISMA, Brunel University, UK. (p. 37)

WB 9:45-10:45 Grand Ballroom

Special Session: A Salute to the Pioneers of Stochastic Programming

Stochastic Programming, as we know it today, could not have flourished to its present state without the insight and dedication of several scholars who provided the field with its early foundations.

Please join us in recognizing the longstanding contributions of:

George B. Dantzig	Kurt Marti
Michael A.H. Dempster	Andras Prékopa
Jitka Dupačová	Stephen M.Robinson
Yuri Ermoliev	R. Tyrell Rockafellar
Peter Kall	Roger J-B Wets
Willem K. Klein Haneveld	William T. Ziemba

Chair: Bob Bixby, Chair of the Mathematical Programming Society

WC 11:00-12:30

Ballroom South: SP Software and Modeling Systems II
Chair: Gus Gassmann, Dalhousie University

1. SLPlib software library for reading SMPS format.
   Andy Felt, U. of Wisconsin-Stevens Point. (p. 37)
2. Multistage Stochastic Linear Programming on a Computational Grid.
   Jeff Linderoth, Lehigh University. (p. 50)
3. Stochastic Programming and Scenario Generation within a Simulation Framework : An Information Systems Perspective.
   Gautam Mitra, CARISMA, Brunel University, UK. (p. 53)

Catalina: Asset Liability Management
Chair: Michael Schuerle, University of St. Gallen

1. Applying Stochastic Programs to Mergers and Acquisitions.
   Batur Bicer, Princeton University. (p. 31)
2. Exchange Rates and the Conversion of Currency-Specific Risk Premia.
   Astrid Eisenberg, Mercer Oliver Wyman. (p. 37)
3. Optimal investment management for unit-linked life-insurance.
   Ronald Hochreiter, University of Vienna. (p. 42)

Rincon: Probabilistic Constraints
Chair: Andras Prékopa, Rutgers University

1. Stochastic Programming with Probabilistic Constraints.
   Laetitia Andrieu, CERMICS-ENPC Paris. (p. 28)
2. On Numerical Calculation of Probabilities According to Dirichlet Distribution.
   Tamás Szántai, Budapest University of Technology. (p. 69)
3. A Variant of the Hungarian Inventory Control Model.
   Nilay Noyan, RUTCOR- Rutgers Center for Operations Research. (p. 55)

Thursday, October 14, 2004

ThA 8:00-9:30

Ballroom South: Portfolio Optimization
Chair: Gerd Infanger, Stanford University

1. The impact of serial correlation of returns on dynamic asset allocation - a multistage stochastic programming approach.
   Alex Collomb, Department of Management Science and Engineering, Stanford University. (p. 33)
2. Hedging fixed income portfolios using multi-stage stochastic programming and simulation.
   Anthony Diaco, Scientific Computing and Computational Mathematics, Stanford University. (p. 35)
3. Dynamic Asset Allocation using Stochastic Programming and Stochastic Dynamic Programming - Models and Strategies.
   Gerd Infanger, Department of Management Science and Engineering, Stanford University. (p. 43)

Catalina: Scenario Generation I
Chair: Michael Casey, University of Puget Sound

1. Computational Experiments With a Dynamic Scenario Genaration Algorithm.
   Leo Lopes, University of Arizona. (p. 52)
2. Scenario selection by dual preference.
   Matthias Nowak, SINTEF. (p. 55)
3. Aggregation and recursion in MSLP's with infinite support.
   Simon Siegrist, Institute for Operations Research, University of Z urich. (p. 65)

Rincon: Statistical Methods in SP
Chair: Jitka Dupačová, Charles University

1. Adaptive Control Variates.
   Sujin Kim, Cornell University. (p. 46)
2. Testing successive regression approximations on large two stage problems.
   Istvan Deak, Budapest University of Technol. (p. 34)
3. Solving Stochastic Mathematical Programs with Complementarity Constraints using Simulation.
   Gul Gurkan, Tilburg University, Netherlands. (p. 40)

ThB 9:45-10:45
Grand Ballroom

Plenary Address: Werner Roemisch,Humboldt-University Berlin

Scenario modelling for multistage stochastic programs.

Chair: Darinka Dentcheva, Stevens Insitute of Techology
(Abstract: p. 62)

ThC 11:00-12:30

Ballroom South: Revenue Management
Chair: Victor DeMiguel, London Business School

1. Multi-Stage Stochastic Programming Models in Revenue Management.
   Tito Homem-de-Mello, Northwestern University. (p. 42)
2. An Application of Scenario Tree Based Stochastic to Airline Revenue Management.
   Andris Möller, Humboldt-University Berlin. (p. 55)
3. Revenue Management with Correlated Demand Forecasting and Multistage Stochastic Programming.
   Victor DeMiguel, London Business School. (p. 34)

Catalina: Scenario Generation II
Chair: Matthias Nowak, SINTEF

1. Scenario reduction methods applied to scenario tree construction.
   Holger Heitsch, Humboldt-University Berlin, Institute of Mathematics. (p. 41)
2. Comparison of Scenario Modifications in Melt Control.
   Pavel Popela, Department of Mathematics, Brno. (p. 59)
3. Vector Autoregressive Models in Multistage Stochastic Programming.
   Patrick Wirth, University of St. Gallen, Switzerland. (p. 75)

Rincon: Sensitivity Analysis
Chair: Dave Morton, University of Texas at Austin

1. Sensitivity Analysis and Asymptotic Properties of Two-Stage Scenario Based Stochastic Programs.
   Jan Polivka, Charles University Prague. (p. 58)
2. Reflections on scenario tree reduction, construction and contamination: computational results..
   Marida Bertocchi, University of Bergamo. (p. 30)
3. Sensitivity analysis and stress testing for VaR and CVaR.
   Jitka Dupačová, Dept. of Statistics, Charles U. (p. 36)

ThD 13:30-15:00

Ballroom South: Stochastic Programming and Hedging
Chair: Leonard Maclean, Dalhousie University

1. A stochastic programming model for asset liability management of a Finnish pension company.
   Petri Hilli, Helsinki School of Economics. (p. 42)
2. Calibrating option implied trees.
   Vittorio Moriggia, University of Bergamo. (p. 54)
3. Bounds on the values of financial derivatives under partial knowledge on the probability distribution.
   Andras Prékopa, RUTCOR, Rutgers University. (p. 60)

Catalina: Computational Issues in Stochastic Programming
Chair: Gus Gassmann, Dalhousie University

1. Scalability and implementation issues in stochastic programming algorithms.
   Chandra Poojari, CARISMA; Bunel University, UK. (p. 59)
2. Computational Experimentation with Stochastic Programming Algorithms.
   Julia L. Higle, University of Arizona. (p. 42)
3. Modeling history-dependent parameters in the SMPS format for stochastic programming.
   H.I. Gassmann, Dalhousie University. (p. 38)

Rincon: Network Design
Chair: Stein Wallace, Molde University College

1. Stochastic service network design.
   Arnt-Gunnar Lium, Molde University College. (p. 52)
2. P-Efficient Points in Design of Stochastic Networks.
   Tongyin Liu, RUTCOR, Rutgers Center for Operations Research. (p. 51)
3. Stochastic Frequency Assignment Problem.
   Abdel Lisser, Université de Paris Sud. (p. 50)

ThE 15:15-16:15
Grand Ballroom

Plenary Address: Teemu Pennanen,Helsinki School of Economics

An analytical approach to stochastic programming.

Chair: Bill Ziemba, University of British Columbia
(Abstract: p. 57)

ThF 16:30-18:30

Ballroom South: Solution Validation
Chair: Dave Morton, University of Texas at Austin

1. Assessing Solution Quality in Stochastic Programs.
   Guzin Bayraksan, The University of Texas at Austin. (p. 30)
2. Solution Validation in Multi-Stage Stochastic Linear Programs.
   Lei Zhao, University of Arizona. (p. 76)
3. Assessing Policy Quality in Multi-stage Stochastic Programming.
   David Morton, University of Texas at Austin. (p. 54)

Catalina: SP for Nontraditional Financial Markets
Chair: Chanaka Edirisinghe, University of Tennessee

1. The CMZ model for speculative markets.
   Giorgio Consigli, University of Bergamo. (p. 33)
2. Arbitrage pricing of financial contracts in incomplete markets.
   Iivo Vehviläinen, Fortum Power and Heat Oy, Finl. (p. 73)
3. Risk Control in a Speculative Financial Market.
   Leonard MacLean, School of Business Administration, Dalhousie University. (p. 53)
4. Arbitrage-free Pricing of Contingent Claims under transactions costs via Generalized Moment Problems.
   Chanaka Edirisinghe, College of Business, University of Tennessee. (p. 36)

Rincon: Scenario Generation III
Chair: Paolo Brandimarte, DSPEA - Politecnico di Torino

1. Evaluation of scenario-generation methods for stochastic programming.
   Stein Wallace, Molde University College, Norway. (p. 74)
2. Scenario Approximation for Portfolio Optimization using CVaR.
   Maksym Bychkov, College of Business, University of Tennessee. (p. 32)
3. Combining scenario generation and forecasting.
   Asgeir Tomasgard, NTNU. (p. 70)
4. Integration quadratures in discretization of stochastic programs.
   Matti Koivu, Helsinki School of Economics. (p. 48)

Friday, October 15, 2004

FA 8:00-9:30

Ballroom South: SP for Global Finance and Insurance
Chair: Roy Kouwenberg, Asian Institute of Technology

1. Multistage portfolio models: Time decomposition in Progressive Hedging Algorithm.
   Elio Canestrelli, University of Venice. (p. 32)
2. Dynamic Asset Liability Management for Swiss Pension Funds.
   Gabriel Dondi, ETH Zürich, Swiss Federal Institute of Technology. (p. 35)
3. Multistage Stochastic Programming Models in Asset & Liability Management.
   Michael Schuerle, University of St. Gallen. (p. 64)

Catalina: Stability and Duality
Chair: Darinka Dentcheva, Stevens Institute of Technology

1. (Sub-)Differentiability and Lipschitz Properties of Singular Normal Distributions.
   Rene Henrion, Weierstrass Institute Berlin. (p. 41)
2. Dynamic Stochastic Programming: Modeling, Information and Optimality.
   Michael Casey, University of Puget Sound. (p. 32)
3. Dual Methods for Probabilistic Optimization Problems.
   Bogumila Lai, St. Joseph's College. (p. 49)

Rincon: Algorithms and Approximations III
Chair: Shabbir Ahmed, Georgia Technological University

1. Strong Formulations for Multi-Item Capacitated Stochastic Lot-Sizing Problems.
   Yongpei Guan, Georgia Institute of Technology. (p. 39)
2. A modified L-shaped method.
   Elisabetta Allevi, University of Brescia, Italy. (p. 28)
3. A Multi-Stage Approach for Stochastic Capacity Planning Problems.
   Kai Huang, Georgia Institute of Technology. (p. 43)

FB 9:45-11:45

Ballroom South: Portfolio Optimization
Chair: Victor DeMiguel, London Business School

1. Drawdown Measure in Portfolio Optimization.
   Stan Uryasev, University of Florida. (p. 72)
2. Portfolio Investment with the Exact Tax Basis via Nonlinear Programming.
   Raman Uppal, London Business School. (p. 72)
3. Designing Minimum Guaranteed Return Funds.
   Muriel Rietbergen, Centre for Financial Research, Judge Institute of Management, University of Cambridge. (p. 61)
4. On the global minimization of the Value-at-Risk.
   Jong-Shi Pang, Department of Mathematical Sciences, Rensselaer Polytechnic Institute. (p. 57)

Catalina: International Finance
Chair: Hercules Vladimirou, University of Cyprus

1. Currency hedging for a multi-national firm.
   Markku Kallio, Helsinki School of Economics. (p. 44)
2. A Stochastic Programming Framework for Managing International Portfolios of Financial Assets.
   Hercules Vladimirou, University of Cyprus. (p. 73)
3. Treasury Management Model with Foreign Exchange.
   Cormac Lucas, Brunel University. (p. 52)

Rincon: Algorithms and Approximations IV
Chair: Huseyin Topaloglu, Cornell University

1. A Primal-Dual Decomposition Algorithm for Multistage Stochastic Convex Programming.
   Roy Kouwenberg, Asian Institute of Technology. (p. 49)
2. Separable approximation strategies for discrete resource allocation under uncertainty.
   Huseyin Topaloglu, Cornell University. (p. 71)
3. Stochastic programming with linear decision rules.
   Julien Thénié, Logilab - University of Geneva. (p. 70)
4. Generalized Bounds for Convex Multistage Stochastic Programs.
   Daniel Kuhn, University of St. Gallen, Institute for Operations Research and Computational Finance. (p. 49)

Abstracts

The abstracts for the presentations can be found in the following pages. They are listed alphabetically by the speaker's last name. Please note that the conference organizers have not edited them in any way (other than to ensure LaTeX compatibility). When multiple authors are associated with an abstract, they are listed alphabetically.

Ahmed, Shabbir. Georgia Institute of Technology
On Solving Stochastic Programs with Integer Recourse
This talk will discuss algorithmic techniques for solving two-stage stochastic programs with pure integer recourse. We will first review an existing branch-and-bound algorithm, and then present some ideas for its enhancement.
(TA, South Ballroom)

Allevi, Elisabetta. University of Brescia, Italy
A modified L-shaped method
In this paper we present a modified version of the basic L-shaped method for solving the two-stage stochastic linear program with fixed recourse. The basic idea of the L-shaped method is to approximate the non-linear penalty term in the objective by a linear one. We use the implicit LX and implicit LP method of the ABS class [1] for the solution of the two-stage linear program. The ABS class contains all known algorithms to solve a linear system starting from an arbitrary point and in a number of iterations no greater than the number of equations. The majority of the direct-type algorithms proposed in the literature have this property and fall therefore into ABS formulation. Using the properties and the special structure of the ABS class and applying them to the two-stage problem the number of operations is greatly decreased with respect to the original L-shaped method. Extension to multistage problem will be sketched.

[1] Abaffy,J., Spedicato, E. (1989) ABS Projection Algorithms. Mathematical techniques for linear and non linear equations., Ellis Horwood Ltd.
(FA, Rincon)

· Abaffy, Jozsef, University of Economic Science

Alonso-Ayuso, Antonio. Universidad Rey Juan Carlos
On structuring energy contract portfolios in competitive markets
A multi-stage full recourse model for structuring energy contract portfolios in competitive markets is presented for price taker operators. The main uncertain parameters are spot price, water exogenous inflow to the hydro system and fuel and gas cost and availability. The weighted reaching probability is considered as a risk measure in the objective function to optimize, by combining it with the maximization of the expected bilateral and spot market trading profit along the time horizon over the scenarios. The uncertainty is represented by a set of scenarios. The problem is formulated as a mixed 0–1 Deterministic Equivalent Model. Only 0–1 variables have nonzero coefficients in the first-stage constraint system. All continuous variables only show up in the formulation of later stages. A problem solving approach based on a splitting variable mathematical representation of the scenario clusters is considered. The approach uses the Twin Node Family concept within the hybrid algorithmic framework presented in the paper. It comprises a Branch-and-Fix Coordination scheme and an Augmented Lagrangian Decomposition scheme for satisfying the nonanticipativity constraints.
(MD, Catalina)

· Escudero, Laureano, Universidad Miguel Hernández de Elche
· Ortuño, M. Teresa, Universidad Complutense de Madrid
· Pizarro, Celeste, Universidad Rey Juan carlos

Andrieu, Laetitia. CERMICS-ENPC Paris
Stochastic Programming with Probabilistic Constraints
The formulation of optimization problems often requires the introduction of constraints in order to express concerns which cannot be reflected by the cost function itself (if the cost is in dollars, the risk of losing one's life is hardly expressed this way). When dealing with systems under uncertainty, very often almost sure constraints are not realistic and constraints on expected values are not meaningful enough. Meeting constraints with a given probability seems to be the appropriate way to reflect those concerns. Unfortunately, such an approach generally raises serious mathematical difficulties even if the underlying deterministic problem (that is, the one in which random variables have no variance and in which

constraints are satisfied exactly) is convex.

Those mathematical difficulties are probably the reason why other expressions of risk constraints are very often preferred (e.g. those using the Conditional Value-at-Risk — CVaR — or second-order stochastic order relations, etc.). Nevertheless, we believe that with such notions, the intuitive insight into the meaning of the level of risk which is assumed is somewhat lost. On the contrary, probabilistic constraints are of immediate understanding.

In this talk, by using very simple but rather generic examples, we show some of the pathologies which may occur both from the point of view of characterizing the solution (that is, writing Kuhn-Tucker conditions) and from that of solving such problems numerically using stochastic approximation algorithms based on duality. We then propose some alternative formulation of the same constraints which provides a remedy to many of those difficulties. Several stochastic approximation algorithms are also examined for both formulations and compared through experiments. Finally, some theoretical results are presented regarding their convergence.
(WC, Rincon)

· Cohen, Guy, CERMICS-ENPC Paris
· Vázquez-Abad, Felisa, Univeristy of Melbourne and Un

Atamturk, Alper. University of California at Berkeley
Strong Formulations of Robust Mixed 0-1 Programming
Robust optimization is a paradigm for finding solutions to an optimization problem when the data of the problem is not fixed, but belongs to a well-defined uncertainty set. In this scheme, one typically aims for a solution that minimizes (or maximizes) an objective function against all possible realizations of the data. From a complexity point of view a desirable property of robust optimization models is that if the nominal problem (the one with fixed data) is solvable in polynomial time, then so is the robust counterpart. Nemirovski et al. have introduced several robust convex optimization models for which this property holds.

Recently Bertsimas and Sim gave an MIP model for robust discrete optimization. They showed that when uncertainty is in the objective coefficients, if a nominal 0-1 problem is solvable in polynomial time, so is the robust counterpart. However, the given robust model has typically very weak LP bound, which makes it difficult to solve in general with an LP-based search algorithm.

In this talk we will describe alternative models for robust 0-1 programming. In particular, we will give three models, all of which have the strongest possible LP relaxation independent of the nominal 0-1 problem. In addition, we will show that there is an LP formulation for a robust 0-1 problem, polynomial in the size of the LP formulation of the nominal 0-1 problem. We will give extensions to robust mixed 0-1 programming and present a summary of computational experiments with the new models.
(TF, South Ballroom)

Avital, Ittai. Naval Postgraduate School
A Chance-Constrained Missile-Procurement Model for Naval Surface Warfare
We model the minimum-cost procurement and allocation of anti-ship cruise missiles to naval combat ships as a chance-constrained, two-period stochastic integer program. Discrete scenarios in two periods define "demands" for missiles (i.e., targets and number of missiles required to prosecute those targets), which must be met with sufficiently high probabilities. After the initial combat period, ships may replenish their inventories from a depot if desired and if the procured depot inventory suffices. We assume the force commander allocates ship-to-target assignments after the set of targets is revealed.
(TF, Rincon)

Barty, Kengy. CERMICS
Discretization of stochastic optimization problems with partial observations
We study the discretization of a partial observation problem. On the one hand a discrete measurability constraint is obtained by the way of a quantization technique ; on the other hand a discrete objective

function is obtained by means of a Monte-Carlo technique. This approach leads to two error terms :

- The quantization error is studied using the strong topology of σ-fields introduced by Neveu in 1970 (J. Neveu, The annals of mathematical statistics, 1972 p. 1369–1371.). We show that under mild assumptions how this error can vanish.
- The Monte Carlo error is more classical and has already be studied by many authors (J. Dupačovánd R. Wets. The annals of statistics 1988 p.1517–1549).

Our main result is a global convergence theorem concerning the sequence of optimal values and of the solutions of the discrete optimization problems as well.
(MF, Rincon)

Bayraksan, Guzin. The University of Texas at Austin
Assessing Solution Quality in Stochastic Programs
Determining whether a solution is of high quality (optimal or near optimal) is a fundamental question in optimization theory and algorithms. In this paper, we develop Monte Carlo sampling-based procedures for assessing solution quality in stochastic programs. Quality is defined via the optimality gap and our procedures' output is a confidence interval on this gap. We review a multiple-replications procedure and then, we present a result that justifies a computationally simplified single-replication procedure. Even though the single replication procedure is computationally significantly less demanding, the resulting confidence interval might have a low coverage probability for small sample sizes for some problems. We provide variants of this procedure that require two replications instead of one and that perform empirically better. Preliminary computational results are presented for a newsvendor problem and for two-stage stochastic linear programs from the literature.
(ThF, South Ballroom)

· Morton, David, The University of Texas at Austin

Bertocchi, Marida. University of Bergamo
Reflections on scenario tree reduction, construction and contamination: computational results.
As a continuation of our paper [a] we shall deal with various techniques suggested to create a sensible scenario tree. We discuss these techniques for financial applications which use as an input scenarios based on Black-Derman-Toy binomial lattice calibrated from market data. Three scenario reduction techniques suggested in [b], [c] will be tested for a two-stage bond portfolio management problem with monthly and quarterly discretization step. For the quarterly discretization case, scenario tree construction based on an additional stage proposed by an expert will be complemented by computational experiments using, inter alia, the recently developed scenario construction method [d]. As the last possibility we exploit the contamination technique [d] for the multistage version of the model to quantify the impact of including additional scenarios and/or additional stages to an already selected scenario tree.

1. Bertocchi, M., Dupačová, J., Moriggia, V. (2004), Horizon and stages in applications of stochastic programming in finance. *Annals of Oper. Res*, to appear.
2. Dupačová, J., Gröwe-Kuska, N., Römisch, W. (2003), Scenario reduction in stochastic programming: An approach using probability metrics. *Math. Programming A* **95**, 493-511.
3. Gröwe-Kuska, N., Heitsch, H., Römisch, W. (2003), Scenario reduction and scenario tree construction for power management problems, GAMS Workshop "Advanced risk management using stochastic programming with financial applications", Heidelberg, Sept. 1-3.
4. Dupačová, J. (1995), Postoptimality for multistage stochastic linear programs. *Annals of Oper. Res.* **56**, 65-78.

(ThC, Rincon)

· Dupačová, Jitka, Charles University of Prague
· Moriggia, Vittorio, University of Bergamo

Bicer, Batur. Princeton University
Applying Stochastic Programs to Mergers and Acquisitions
Global financial institutions continue to consolidate through mergers and acquisitions. Traditional risk management methods such as RAROC misestimate the extreme risks for the merged enterprise, thus reducing risk-adjusted profits. We develop an enterprise risk management system based on a stochastic program. The SP can be solved directly for well focused institutions, such as re-insurance companies, or by means of a decentralized approach for global institutions possessing diverse operations. A real-world example depicts the advantages of the approach over current risk management practice. State prices, for example, are directly accessible.
(WC, Catalina)

· Mulvey, John, Princeton University

Birbilis, George. Brunel University, UK
Intelligent Risk Management Approach: Dynamic Risk Measures
In a competitive environment institutions are forced to implement an enterprise-wide integrated risk return management. Enterprise Risk Management objective is to identify, measure, control and manage the risk in a holistic, top-down, integrated, and comprehensive manner of the whole organisation across all risk categories. The principle contribution of this research is to provide a methodology for the Enterprise Risk Management called Intelligent Risk Management Approach (IRMA). The research lies within the intersection of three distinct domains. The first is simulation technology. The second domain is decision science. The third domain is artificial intelligence.

IRMA addresses the following issues:
- The requirements from a simulation and software agent perspective of such a system. One of the reasons that no such system has previously been built is that the requirements have never before been articulated.
- Dynamic adaptation of the system in general and the simulation in particular over time.

The overall benefit of this research is to build a foundation on which other tools and software agents can be built. This methodology will support quick, accurate assessment of the rapidly changing environment. Given a production system with the capabilities of the prototype system we could use available information significantly better than any method used previously.
(MD, Rincon)

Birge, John. University of Chicago
Integrating Financial and Operational Risks via Multi-Stage Stochastic Programming
Large organizations typically separate financial decisions from operational decisions. The result of such separation can be significant risk exposures and substantial losses relative to integrative decision making. We will present a model of the firm that demonstrates the potential gains of integrated decision making. The model follows a multi-stage stochastic programming form that includes an innovative approach to ensure that borrowing rates are consistent with debt levels.
(WA, South Ballroom)

· Xu, Xiaodong, Northwestern University

Brandimarte, Paolo. DISPEA - Politecnico di Torino
Multi-item capacitated lot-sizing with demand uncertainty
We consider a stochastic version of the classical multi-item Capacitated Lot-Sizing Problem (CLSP). Demand uncertainty is explicitly modeled through a scenario tree, resulting in a multi-stage mixed-integer stochastic programming model with recourse. We adopt a plant-location based model formulation and a heuristic solution approach based on a fix-and-relax strategy. We report computational experiments to assess not only the viability of the heuristic, but also the advantage (if any) of the stochastic programming model with respect to the considerably simpler deterministic model based on expected value of demand. To this aim we use a simulation architecture, whereby the production plan obtained from the optimization models is applied in a realistic rolling horizon framework, allowing for out-of-sample scenarios and errors in the model of demand uncertainty. We also experiment with different approaches to generate the scenario tree. The results suggest that there is an interplay between different managerial levers to hedge demand uncertainty, i.e., reactive capacity buffers and safety stocks. When there is enough reactive capacity, the ability of the stochastic model to build safety stocks is of little value. When capacity is tightly constrained and the impact of setup times is large, remarkable advantages are obtained by modeling uncertainty explicitly.
(TF, Catalina)

Bychkov, Maksym. College of Business, University of Tennessee
Scenario Approximation for Portfolio Optimization using CVaR
Using the basic ideas of CVaR, this paper develops a new methodology for scenario approximation for stochastic portfolio optimization. First, the concept of "Scenarios-at-Risk" (SaR) is proposed as a way of partitioning the underlying multivariate domain for a fixed portfolio and a fixed level of CVaR. Then, under a suitable set of CVaR levels, a two-stage method is developed for determining a smaller, and discrete, set of scenarios over which CVaR risk control is satisfied for all portfolios of interest. Convergence of the method is shown and numerical results are presented.
(ThF, Rincon)

· Edirisinghe, Chanaka, College of Business, University of Tennessee

Canestrelli, Elio. University of Venice
Multistage portfolio models: Time decomposition in Progressive Hedging Algorithm
We consider dynamic portfolio management problems over a finite horizon. We assume that theuncertainty faced by the investor can be modelled or approximated using discrete probability distributions via a scenario approach. To solve the resulting optimization problem we apply Progressive Hedging Algorithm obtaining a scenario decomposition. To take advantage of the structure of the portfolio problem we propose a further decomposition with respect to time obtained by means of a discrete version of the Maximum Principle. We apply this approach to a multistage tracking error problem. We are interested in dynamically replicating a benchmark using only a small subset of assets, considering transaction costs and a liquidity component. We numerically test our model on real data by dynamically replicating the MSCI Euro index. We consider an increasing number of scenarios and assets and show the superior performance of the dynamically optimized tracking portfolio over static strategies.
(FA, South Ballroom)

· Barro, Diana, University of Venice

Casey, Michael. University of Puget Sound
Dynamic Stochastic Programming: Modeling, Information and Optimality
A dynamic stochastic program is a type of multistage stochastic program where a distinction is made between state and control and the state evolves according to a set of dynamical equations which can be brought into the model as constraints. This models a discrete-time stochastic optimal control problem. To be comprehensive, the dynamic stochastic program ought to include formulations in which the controller has only partial state information, or may respond to information exogenous to the system state. A general

stochastic programming formulation of stochastic optimal control problems is presented that encompasses this enhanced information structure, optimality conditions are presented and a general duality theory is developed for these problems.
(FA, Catalina)

· Korf, Lisa, University of Washington

Collomb, Alex. Department of Management Science and Engineering, Stanford University
The impact of serial correlation of returns on dynamic asset allocation - a multistage stochastic programming approach
In many situations serial correlation of asset returns can be observed. We model serial correlation by a vector autoregressive returns generating process and solve a multistage stochastic program for obtaining the optimal asset allocation strategy. We compare the results obtained in the base case of i.i.d. asset returns to different levels and structures of the autoregressive process and study the variations of the optimal asset allocation decisions, transaction costs, and returns achieved.
(ThA, South Ballroom)

· Infanger, Gerd, Department of Management Science and Engineering, Stanford University

Consigli, Giorgio. University of Bergamo
The CMZ model for speculative markets
The expansion of international liquidity and free capital mobility across global financial markets in the last two decades has increased the likelihood and scope of financial instability events induced by sudden changes of market agents' expectations resulting in the emergence of so called speculative bubbles. These bubbles represent dramatic violations of the canonical assumptions of return normality common in mainstream finance and have pushed the adoption of new models for optimal risk control in speculative markets. We discuss the general formulation of a return model with equity, bonds and cash, with an underlying random vector process with Gaussian and Poisson noise, in which speculative conditions in the equity markets are captured via the Poisson process and related to the divergence between equity and bond premiums. These are introduced in the model as hidden variables driving the market performance. We present an innovative estimation procedure of a Poisson mixture of Gaussian likelihood functions relying on a Bayesian update, tested with respect to US equity and bond data, and resulting in the solution of a nested sequence of non linear optimisation problems. The model is shown to be consistent with both normal market behaviour and during the emergence of a bubble. The complexity of the presented procedure is also due to the fact that unlike other statistical procedures, here a severe market shock – due to the explosion of the bubble – does typically occur without any previous warning statistical signal. In two related talks (Ziemba and MacLean) a risk control methodology leading to improved portfolio performance and risk management in presence of this source of instability, is described in detail. We consider in particular the effectiveness of alternative strategies formulated as dynamic control problems on portfolios including stocks, bonds and cash. Alternative risk constraints are proposed, namely portfolio variance, Value-at-Risk (VaR) and Conditional Value-at-Risk (CVaR).
(ThF, Catalina)

· Ziemba, William T., Sauder School of Business, University of British Columbia

Das, Tapas. University of South Florida
Performance Evaluation of Various Auction Strategies in Stochastic Energy Market Operation Games
Deregulated power markets across the world use different auction strategies for pricing electricity. We develop an OPF based methodology for assessing the impact of existing auction mechanisms on the performance of energy markets. The methodology is tested using sample networks available in MATPOWER.
(TC, Catalina)

· Nanduri, Vishnuteja, University of South Florida

Deak, Istvan. Budapest University of Technol
Testing successive regression approximations on large two stage problems
Successive regression approximation technique has proved to be succesful on optimizing several stochastic programming problems. We tested the solution technique on two stage problems, identified the numerical trouble spots and proposed enhancements to numerical techniques used. Making use of Kall-Mayer techniques we generated random two stage problems and solved them. Problems have up to 100 first stage decision variables and up to 100 second stage random right hand side variables - the distribution of the random variables was mostly normal. Computer running times are also given.
(ThA, Rincon)

DeMiguel, Victor. London Business School
Revenue Management with Correlated Demand Forecasting and Multistage Stochastic Programming
We propose a revenue-management methodology with two innovative features. First, we develop a forecasting model taking into account correlation between demand across different products and time periods. Second, we determine bid prices using an optimization algorithm based on multistage stochastic programming. We test the methodology with real airline booking data.
(ThC, South Ballroom)

· Fridgeirsdottir, Kristin, –
· Mishra, Nishant, London Business School
· Stefanescu, Catalina, London Business School
· Zenios, Stefanos, Stanford University

Demirci, Mehmet. University of Pittsburgh
Column Generation within Stochastic Programming
The L-Shaped method is perhaps the most widely used algorithm for solving two-stage stochastic linear programs. In this algorithm, a restricted master problem (RMP) containing only the first-stage variables is formed along with feasibility and optimality subproblems, both containing only the second-stage variables and taking the values of the first-stage variables as an input from the master problem. After solving the RMP, the values of first-stage variables are passed on to the subproblems and the subproblems are solved. By using the dual variables of the subproblem, feasibility and optimality cuts are generated and inserted into the RMP. Afterwards, the RMP is solved with a new set of constraints and the algorithm proceeds iteratively until optimality is reached. Column generation methodology is commonly used to solve mathematical problems that involve a large number of variables. Instead of considering all the columns of such a problem explicitly, column generation techniques employ a master problem that contains a subset of all possible columns and a pricing subproblem that generates promising new columns. The algorithm follows a loop in which the master problem is solved and the dual solution is passed on to the pricing problem, which tries to find the most favorable reduced cost among excluded columns. If such a column exists, it is inserted into the master problem and if not, the algorithm stops. We introduce a method for incorporating column generation within a stochastic programming framework. This method generates columns for the RMP, while simultaneously adding feasibility and optimality cuts generated from the second-stage subproblems. We discuss convergence issues and preliminary computational results.
(TD, South Ballroom)

· Hunsaker, Brady, University of Pittsburgh
· Rosenberger, Jay, University of Texas at Arlington
· Schaefer, Andrew, University of Pittsburgh

Dempster, Michael A H. University of Cambridge and Cambridge Systems Associates Limited
Dynamic Stochastic Programming in Financial Planning Applications
Experience with commercial applications of dynamic stochastic programmes to financial planning problems

involving variously long term asset allocation, asset liability management, pricing and hedging strategies and risk management has lead to the development of sophisticated techniques for model validation and performance testing. This talk will give an overview of the technical lessons learned regarding complex scenario generation, tree shapes, stability testing, Monte Carlo testing and historical back testing. Consideration will be given to model generation, experimental design, sample size, statistical power and solution visualisation from the practical viewpoint of run-time and memory requirements.
(WA, South Ballroom)

Dentcheva, Darinka. Stevens Institute of Technology
Risk-averse stochastic optimization: semi-infinite chance constraints
We discuss stochastic optimization problems with continuum of chance constraints arising in the context of stochastic dominance of first order. This type of constraints, frequently called stochastic ordering constraints, has been introduced in statistics and further applied and developed in economics. We develop first order necessary and sufficient conditions of optimality for these models. We show that the Lagrange multipliers corresponding to dominance constraints are piecewise constant non-decreasing utility functions. We also show that the convexification of stochastic ordering relation is equivalent to second order stochastic dominance relation. The model represents a new approach to decisions under uncertainty in which random outcomes dependent on our decisions are compared with stochastic reference points. The analysis demonstrates that the expected utility approach is dual to the new one.
(TD, Rincon)

· Ruszczynski, Andrzej, Rutgers University

Diaco, Anthony. Scientific Computing and Computational Mathematics, Stanford University
Hedging fixed income portfolios using multi-stage stochastic programming and simulation
Simulation and multi-stage stochastic programming is used for the optimization of fixed income investment portfolios. The model includes US Treasuries of various maturities, and corresponding options and futures, and minimizes downside risk for given expected return. We analyze the contribution of options and futures with respect to downside risk, and compare portfolios obtained from using various interest rate processes.
(ThA, South Ballroom)

· Infanger, Gerd, Department of Management Science and Engineering, Stanford University

Dondi, Gabriel. ETH Zürich, Swiss Federal Institute of Technology
Dynamic Asset Liability Management for Swiss Pension Funds
In this talk we present a detailed liability model tailored to the specific case of Swiss pension funds. Also, we present an asset dynamics model and propose an optimisation technique to solve the problem of allocating the funds with regard to the liabilities maturity structure. Our liability model is based on the current and projected future cash outflows towards all members, taking into account: projection of the individuals income, probabilities of entry and exit of members, probabilities of death and invalidity of members. This results in a dynamic, stochastic description of pension fund liabilities. The projected uncertain future cash flows are sorted by their date of payment. Payments in a certain period are summed up in what we call liability buckets. The buckets give a manageable description of the pension funds liabilities and their term structure.

The assets are modelled from the perspective of a Swiss investor where we use a dynamic factor model with heavy tailed residuals to model stock and bond markets. We propose an optimisation technique for the asset liability management problem where the liability buckets are matched with available cash in the pension fund. The optimisation problem is to minimise the shortfall of bucket funding while reaching a required future surplus. The solution results in an asset allocation for each liability bucket based on its time horizon.
(FA, South Ballroom)

· Geering, Hans P., ETH Z urich, Swiss Federal Institute of Technology

· Herzog, Florian, ETH Z urich, Swiss Federal Institute of Technology

Dupačová, Jitka. Dept. of Statistics, Charles U
Sensitivity analysis and stress testing for VaR and CVaR
Contamination technique in stress testing for risk measures Value at Risk (VaR) and Conditional Value at Risk (CVaR) will be discussed and illustrated numerically. This is straightforward for CVaR evaluation and/or optimization and the obtained results serve to a genuine stress *quantification*. Stress testing via contamination for CVaR-mean return efficient frontier turns out to be more delicate.

The presence of the simple chance constraint in definition of VaR requires that for VaR stress testing via contamination, various distributional and structural properties are fulfilled for the original, unperturbed problem. These requirements rule out direct applications of the contamination technique in case of discrete distributions, which includes the empirical VaR. Nevertheless, even in this case, it is possible to construct bounds for VaR of the contaminated distribution. In the case of normal distribution and parametric VaR one may exploit stability results valid for quadratic programs to stress testing of VaR optimization problems.

The presented approaches provide a deeper insight into stress behavior of VaR and CVaR than the common numerical evaluations based solely on backtesting and out-of-sample analysis. A possible extension to other risk measures will be discussed.
(ThC, Rincon)

Edirisinghe, Chanaka. College of Business, University of Tennessee
Arbitrage-free Pricing of Contingent Claims under transactions costs via Generalized Moment Problems
This paper is concerned with state space pricing, for instance in discrete-time multi-period scenario trees, such that the state prices are arbitrage-free. It is well known that the absence of arbitrage profits in the state space is equivalent to the existence of a martingale probability measure when there are no trading costs. When such trees are utilized in stochastic programming, for instance in pricing contingent claims defined on the state space, the problem reduces to one of solving a generalized moment problem at each node. Appealing to well-known bounding results from the literature, we propose a simplicial upper bounding procedure based on recursive backward dynamic programming when the state price space is multidimensional and continuous. This serves to formalize known results as well as to provide extensions. The results are also generalized to the case of when proportional transactions costs are present for trading. With increased transactions costs, it is shown why arbitrage-free multi-period (state price) scenario trees are easier to generate. Geometric interpretations and preliminary computational results will be presented.
(ThF, Catalina)

Eichhorn, Andreas. Humboldt-University Berlin
Mean-risk optimization of electricity portfolios using polyhedral risk measures
We present a multistage stochastic programming model for mean-risk optimization of electricity portfolios containing physical components and energy derivative products. The model is designed for a municipal power utility and considers a medium term optimization horizon of one year in hourly discretization. Stochasticity enters the model via the uncertain (time-dependent) prices and electricity demand. The objective is to maximize the expected overall revenue and, simultaneously, to minimize a multiperiod risk measure, i.e., a risk measure that takes into account the intermediate time book values of the portfolio. We compare the effect of different multiperiod risk measures taken from the class of polyhedral risk measures which was suggested in our earlier work. For this purpose, simulation results of the model are presented and discussed.
(MD, Catalina)

· Römisch, Werner, Humboldt-University Berlin
· Wegner, Isabel, Humboldt-University Berlin

Eisenberg, Astrid. Mercer Oliver Wyman

Exchange Rates and the Conversion of Currency-Specific Risk Premia

How do the risk factors that drive asset prices influence exchange rates? Are the parameters of asset price processes relevant for specifying exchange rate processes? Since most international asset pricing models focus on the analysis of asset returns given exchange rate processes, there is only little work on these questions. This paper uses an international stochastic discount factor (SDF) framework to analyze the interplay between asset prices and exchange rates. So far, this approach has only been implemented in international term structure models. We find that exchange rates serve to convert currency-specific discount factors and currency-specific prices of risk – a result linked to the international arbitrage pricing theory (IAPT). Our empirical investigation presents evidence for the conversion of currency-specific risk premia by exchange rates.

(WC, Catalina)

· Rudolf, Markus, WHU Otto-Beisheim Graduate School of Management

Ellison, Frank. CARISMA, Brunel University, UK

Algorithms for the solution of large-scale quadratic programming (QP) models

Sparse simplex method (SSX) and the interior point method (IPM) are two well established algorithms for solving convex quadratic programming (QP) problems. We consider the algorithms and computational implementation of these two methods. We discuss the application of these two algorithms to a set of benchmark problems. We also present our computational experience with the QP models used in the regularized formulation arising in the L-shaped method and the stochastic decomposition algorithm for SP.

(WA, Rincon)

· Guertler, Marion, CARISMA, Brunel University, UK
· Mitra, Gautam, CARISMA, Brunel University, UK

Escudero, Laureano. Universidad Miguel Hernández

On the BFC approach for multistage stochastic mixed 0–1 program solving

We present the main ideas of the Branch-and-Fix Coordination approach for solving multistage mixed 0-1 problems under uncertainty in the objective function coefficients and the right-hand-side vector. A scenario analysis scheme is used. The problem is modelled by a splitting variable representation of the mixed 0-1 Deterministic Equivalent Model, jointly with a compact representation for the scenario-cluster models in the problem. So, a mixed 0-1 model for each scenario cluster is considered plus the non-anticipativity constraints that equate the 0-1 and continuous variables from the same group of scenarios in each stage. The non-anticipativity constraints for the 0-1 variables are satisfied by using a Twin Node Family scheme. Benders and Lagrangian Decomposition approaches are used for satisfying the non-anticipativity constraints for the continuous variables.

(TF, South Ballroom)

· Alonso-Ayuso, Antonio, Universidad Rey Juan Carlos
· Garin, Araceli, Universidad del Pais Vasco
· Ortuño, Maria Teresa, Universidad Complutense de Madrid
· Perez, Gloria, Universidad del Pais Vasco

Felt, Andy. U. of Wisconsin-Stevens Point

SLPlib software library for reading SMPS format

SLPlib is an open source software library which reads a significant subset of SMPS format. Recent improvements include extension from the two-period case to the general multi-period case, expansion of the allowable forms to scenarios, block discrete and independent discrete, reduced memory requirements, and improved usability. SLPlib is not tied to any solver or solution method, but rather is intended to be used as a resource within a solver to help ease the pain of interfacing with problems in SMPS format.

(WC, South Ballroom)

Fleten, Stein-Erik. NTNU - Norwegian U of Sci and Tech
Constructing bidding curves for a price-taking electricity retailer
We propose a stochastic linear programming model for constructing piecewise linear bidding curves to be submitted to Nord Pool, the Nordic power exchange. We consider the case of a price-taking power marketer who supplies electricity to price-sensitive end users. The objective is to minimize the expected cost of purchasing power from the day-ahead energy market and the short term balancing market. The model is illustrated using a case study with data from Norway.
(MC, Catalina)

· Pettersen, Erling, NTNU - Norwegian U of Sci and Tech

Gaivoronski, Alexei. Norwegian University of Science and Technology
Stochastic Programming Models for Risk Budgeting
Risk Budgeting is an important trend in risk management of complex portfolios. Typically, portfolio of assets of an agent like insurance company or a pension fund consists of large variety of diverse assets which are managed according to different principles. For example, a bulk of portfolio may be invested in a few index funds, while a smaller, but significant portion may be allocated to traders pursuing different active investment strategies. Such portfolio consists from complex assets which not only have different risk profiles, but are exposed to risk of substantially different nature. Statistical properties of these risk types can be known with different levels of uncertainty, and, moreover, the levels of risk aversion of financial actors towards these risk types can differ. Traditional risk management tools like Markowitz model may be insufficient in such situation because they tend to treat all risk types from a uniform perspective. Risk budgeting explicitly recognizes different nature of different types of risk and controls them separately within the general risk management framework. In this paper we present stochastic optimization models related to risk budgeting, study their properties and provide some examples.
(TC, South Ballroom)

· Krylov, Sergiy, Norwegian University of Science and Technology

Gassmann, H.I.. Dalhousie University
Modeling history-dependent parameters in the SMPS format for stochastic programming
The SMPS format – old as it is – is still the only widely recognized way to communicate a stochastic programming problem to a solver. This talk describes several ways in which history-dependent parameters can be described effectively.
(ThD, Catalina)

Goel, Vikas. Carnegie Mellon University
A Class of Stochastic Programs with Decision Dependent Uncertainty
Most previous work in the stochastic programming literature deals with problems with *exogenous uncertainty* Jonsbraten, T.W. [1998] (Ph. D. Thesis, Department of Business Administration, Stavanger College, Norway.), where the optimization decisions cannot influence the stochastic process. In contrast, previous work on problems with *endogenous uncertainty*, where the underlying stochastic process is influenced by the optimization decisions, is limited to a few papers only. The major concern in the case of endogenous uncertainty is that the standard approach to formulation of stochastic programs cannot be used for such problems. For example, if the resolution of (endogenous) uncertainty depends on the optimization decisions, then the scenario tree is decision dependent and hence set of the non-anticipativity constraints to be included in the model is "variable".

In this paper, we address the class of problems that have both exogenous and endogenous uncertainties. The endogenous uncertainty is such that the optimization decisions determine when some uncertainty is resolved. Based on the work of Goel and Grossmann [2004](*Computers and Chemical Engineering*, **28(8)**, 1409-1429.), we develop a novel approach to formulation of stochastic programs for these problems. In this formulation, a unique set of decision variables is defined for each scenario while decisions for two scenarios are linked by conditional non-anticipativity constraints. The conditional non-anticipativity constraints account for the dependence of the scenario tree on the optimization decisions.

We show that the non-anticipativity constraints need not be applied for each pair of scenarios. In particular, non-anticipativity constraints have to be applied for two scenarios only if the scenarios either differ exclusively in the realization of one endogenous parameter, or differ only in realizations of exogenous parameters. This property leads to a drastic reduction in the size of the stochastic program.

We also present a rigorous Lagrangean duality based branch and bound algorithm to solve the reduced model. In this algorithm, upper bounds (maximization case) at each node are obtained by solving a Lagrangean dual problem where the equality non-anticipativity constraints are dualized whereas the disjunctions are relaxed. Lower bounds are obtained by heuristically generating feasible solutions from the solution of the Lagrangean dual problem. The advantages of the proposed theoretical and computational approach are illustrated through a set of examples.
(TD, Catalina)

· Grossmann, Ignacio, Carnegie Mellon University

Goemans, Michel. MIT
Approximating the Stochastic Knapsack Problem: The Benefit of Adaptivity
We consider a stochastic multi-stage variant of the NP-hard 0/1 knapsack problem in which item values are deterministic and item sizes are independent random variables with known, arbitrary distributions. Items are placed in the knapsack sequentially, and the act of placing an item in the knapsack instantiates its size. Our goal is to compute a policy that maximizes the expected value of items placed in the knapsack, and we consider both non-adaptive policies (that designate a priori a fixed sequence of items to insert, and hence do not take advantage of recourse) and (multi-stage) adaptive policies (whose decision of which item to place in the knapsack depends on the sizes of items placed in it thus far). We derive an upper bound on the expected value of the best adaptive policy, and this upper bound relies on a simple linear programing relaxation of the deterministic knapsack problem. We show that adaptivity provides only a constant-factor improvement by demonstrating a greedy non-adaptive algorithm that approximates the optimal adaptive policy (and our upper bound) within a factor of 7. We also design an adaptive polynomial-time algorithm which approximates the optimal adaptive policy within a factor of $5 + \epsilon$, for any constant $\epsilon > 0$. Finally, we prove that finding an optimal adaptive policy is PSPACE-hard. If time permits, we will also discuss extensions to more general models.
(MD, South Ballroom)

· Dean, Brian C., MIT
· Vondrak, Jan, MIT

Gosavi, Abhijit. SUNY, Buffalo
A Quality-of-Service performance measure in queues with Poisson arrivals
We present an exact model for the distribution of the number stranded in a queue with bulk service and Poisson arrivals. Existing approaches in the literature for this problem require a complicated process that involves solving equations with complex zeroes. Our approach is based on a simple Markov-chain approach. Numerical results related to air-transport systems and manufacturing systems will be presented.
(TC, Catalina)

· Kahraman, Aykut, SUNY, Buffalo

Guan, Yongpei. Georgia Institute of Technology
Strong Formulations for Multi-Item Capacitated Stochastic Lot-Sizing Problems
We show that the recently introduced (Q, S_Q)-inequalities describe the convex hull for two period single item stochastic lot-sizing problems.We also develop extensions of the (Q, S_Q) inequalities and introduce new lifting procedures. We implement a branch-and-cut algorithm for the multi-item capacitated

stochastic lotsizing problem that uses (Q, S_Q) inequalities as cutting planes and we present computational results that demonstrate the efficiency of our approach.
(FA, Rincon)

· Ahmed, Shabbir, Georgia Institute of Technology
· Nemhauser, George L., Georgia Institute of Technology

Guessow, Jens. University of St. Gallen, Institute for Operations Research and Computational Finance
Dynamic Portfolio Optimization in Electric Power Trading
In competitive electricity markets, especially small and mid-sized companies involved in power trading are confronted with limited and unstable price information. This deficiency basically stems from the non-storability and grid-bound nature of electric power, complemented by seasonalities and irregular fundamental changes of market conditions. The resulting difficulties for adequate decision support therefore not only include the characteristic seasonal jump-spike price processes, but also structural breaks must be handled in almost any liberalized electricity market. Over the last few years, these difficulties have been subject to extensive research in multistage stochastic optimization. An important advantage of multistage stochastic programs compared to analytical approaches is a normally reduced dependence on necessary conditions of the stochastic processes.

We present the results from a stochastic model with structural properties that have been well analyzed in theory and practice over recent years. Flexibility, stability and moderate problem dimensions are major goals, which can be achieved by a modularly extendable model that in our case automatically calibrates itself with respect to the underlying stochastic processes and decisions. The results are considerable speed-ups in calculation times using a sophisticated model approach as well as a high degree of flexibility with respect to extensions, e.g. the integration of new trading opportunities.
(MD, Catalina)

Gurkan, Gul. Tilburg University, Netherlands
Solving Stochastic Mathematical Programs with Complementarity Constraints using Simulation
Recently, simulation-based methods have been successfully used for solving challenging stochastic optimization problems and equilibrium models. We report some of the recent progress we had in broadening the applicability of so-called the sample-path method to include the solution of certain stochastic mathematical programs with equilibrium constraints. We first describe the method and the class of stochastic mathematical programs with complementarity constraints that we are interested in solving and then outline a set of sufficient conditions for its almost-sure convergence. We also illustrate an application of the method to solving a toll pricing problem in transportation networks. These developments also make it possible to solve certain stochastic bilevel optimization problems and Stackelberg games, involving expectations or steady-state functions, using simulation.
(ThA, Rincon)

· Birbil, Ilker, Sabanci University, Istanbul, Turkey
· Listes, Ovidiu, Tilburg University, Netherlands

Haarbrücker, Gido. University of St.Gallen
Valuation of Electricity Swing Options by Multistage Stochastic Programming
We present a multistage stochastic programming approach for the valuation of a so-called *Swing Option*. This special power derivative gives the option holder the right to buy (or sell) energy at a fixed strike price during an exercise period contracted. Typically, exercise takes place on an hourly basis between some lower and upper power limit and is restricted to pre-determined hours (e.g. peak, off-peak, etc.); further restrictions may be given in form of a lower and/or upper energy limit – i.e. limits for the cumulative exercise over the whole contract period – as well as *ramping constraints* which narrow the change in exercise for consecutive hours.
In order to valuate these kind of options, we take the position of an option holder having access to the respective energy spot market: the 'fair' option value can then be determined as the maximum expected

profit when optimally exercising the swing option and making the respective counter-trade on the spot market. Naturally, this deserves for an efficient exercise strategy which is feasible with respect to the swing option's specifications and which takes into account the uncertain spót price evolution. For this purpose, a multistage stochastic program is set up whereby some approximation and aggregation steps are carried out to reduce numerical complexity. In particular, convex combinations of specific exercise profiles are used in order to overcome the burden of hourly decision variables.
Relying on a forward price model driven by several risk factors, numerical results are achieved which demonstrate the suitability of the approach presented.
(MC, Catalina)

· Kuhn, Daniel, University of St.Gallen, Institute for Operations Research and Computational Finance

Heitsch, Holger. Humboldt-University Berlin, Institute of Mathematics
Scenario reduction methods applied to scenario tree construction
Stochastic programming deals with optimization problems under uncertainty. Typically, such problems use a set of scenarios to model the probabilistic information on random data. Since the corresponding deterministic equivalents of multi-stage stochastic programs are often of high dimension, one main question is: How to find significant scenarios based on a large number of historical or simulated scenarios. With respect to stability results for multi-stage stochastic programs we use some adapted scenario reduction algorithms to construct multivariate scenario trees. The method is based on successively deleting and bundling of scenarios of some given (may be large) set of scenarios by using a probability metric of Fortet-Mourier type, which measures the distances of the initial scenario set to its approximations. Numerical experience is reported for constructing scenario trees for different applications.
(ThC, Catalina)

· Römisch, Werner, Humboldt-University Berlin, Institute of Mathematics

Held, Harald. University Duisburg-Essen
A Decomposition Algorithm Applied to Planning the Interdiction of Stochastic Networks
We describe the application of a decomposition based solution method to a class of network interdiction problems. The problem of maximizing the probability of sufficient disruption of the flow of information or goods in a network whose characteristics are not certain is shown to be solved effectively by applying a scenario decomposition method developed by Riis and Schultz. Computational results demonstrate the effectiveness of the algorithm and design decisions that result in speed improvements.
(MC, South Ballroom)

· Hemmecke, Raymond, Otto-von-Guericke-University
· Woodruff, David L., University of California, Davis

Henrion, Rene. Weierstrass Institute Berlin
(Sub-)Differentiability and Lipschitz Properties of Singular Normal Distributions
The need for calculating and characterizing singular normal distributions arises when considering chance constraints of the type $P(A\xi \leq b(x)) \geq p$, where A is a rectangular matrix having more rows than columns, b is some function and ξ has a nondegenerate multivariate normal distribution. Passing to the transformed random variable $\eta = A\xi$, the constraint can be equivalently rewritten as $F_\eta(b(x))$, where F_η is the distribution function of η. In contrast to ξ, η has a singular normal distribution. In general, F_η need not even be continuous. The talk provides an equivalent criterion for Lipschitz continuity of F_η and characterizes differentiability and subdifferentiability of F_η. The latter results heavily rely on an inclusion/exclusion formula which has recently been proved by Bukszar/Henrion/Hujter/Szantai. The same formula allows for efficient calculation of singular normal distributions in moderate dimensions.
(FA, Catalina)

Higle, Julia L.. University of Arizona
Computational Experimentation with Stochastic Programming Algorithms
Computational experimentation in stochastic programming often involves multiple algorithms that may be structurally unrelated, as well as an assortment of computing environments. Because these algorithms are designed to solve the same problem, the question arises as to "how" to make meaningful comparisons of their operational characteristics. Based on currently on-going investigations, we discuss performance measures and experimental techniques that can be useful in this undertaking. Preliminary computationas are used for illustrative comparisons.
(ThD, Catalina)

- Powell, Warren, Princeton University
- Topaloglu, Huseyin, Cornell University
- Zhao, Lei, University of Arizona

Hilli, Petri. Helsinki School of Economics
A stochastic programming model for asset liability management of a Finnish pension company
This paper describes a stochastic programming model that was developed for asset liability management of a Finnish pension insurance company. In many respects the model resembles those presented in the literature, but it has some unique features stemming from the statutory restrictions for Finnish pension insurance companies. Particular attention is paid to modeling the stochastic factors, numerical solution of the resulting optimization problem and evaluation of the solution. Out-of-sample tests clearly favor the strategies suggested by our model over static fixed-mix and dynamic portfolio insurance strategies.
(ThD, South Ballroom)

- Koivu, Matti, Helsinki School of Economics
- Pennanen, Teemu, Helsinki School of Economics
- Ranne, Antero, Ilmarinen Mutual Pension Insurance Company

Hochreiter, Ronald. University of Vienna
Optimal investment management for unit-linked life-insurance
Scenario-based stochastic programming techniques are a valuable approach to tackle long-term investment problems as they appear e.g. in the insurance industry. Recently, unit-linked life-insurance contracts with guarantee are attracting customers by providing a combination of insurance and investment. In this paper a multi-stage scenario-based stochastic programming model for optimal investment management of such contracts is presented. One feature of the underlying optimization model is that it extends classical multi-stage models with the asset category of insurance as an additional hedging instrument. Furthermore, the death and survival benefit model is integrated into the main scenario generation technique, which provides an interesting framework to investigate the combination of theoretical and practical scenario generation methodologies. A mixture of randomized Quasi Monte Carlo sampling and/or optimal scenario reduction based on probability metrics is applied to calculate the initial scenario tree which is then modified contract-specifically in a second step. This two-tiered scenario method enlarges the degrees of freedom to modify the underlying stochastic model to the needs and beliefs of the financial manager as well as contract-specific parameters. Numerical examples will substantiate the value of this approach. Computational issues for preparing and solving contracts with many stages are discussed.
(WC, Catalina)

- Pflug, Georg, University of Vienna

Homem-de-Mello, Tito. Northwestern University
Multi-Stage Stochastic Programming Models in Revenue Management
We discuss the use of stochastic programming models in revenue management, focusing on the classical seat allocation problem. We first show how such models can improve upon more traditional LP-based methods. The new models also allow for the derivation of stochastic bid prices, which can be compared to

the values derived from the standard bid-price policy for LPs. We then present a non-linear multi-stage stochastic program and describe some characteristics of it (notably lack of convexity). Finally, we discuss some strategies for obtaining approximating solutions to the problem and assessing their quality. Numerical results are presented to illustrate the approach.
(ThC, South Ballroom)

· Chen, Lijian, Ohio State University

Huang, Kai. Georgia Institute of Technology
A Multi-Stage Approach for Stochastic Capacity Planning Problems
We study a general class of strategic capacity planning problems under uncertainty. A multi-stage mixed integer stochastic program is developed and useful bounds are developed to justify the Value of Multi-stage Stochastic Program. By decomposition, an efficient heuristic is proposed, where the simple stochastic lot-sizing problem is identified as a key sub structure and solved optimally. The heuristic solution is shown to be asymptotically optimal.
(FA, Rincon)

· Ahmed, Shabbir, Georgia Institute of Technology

Infanger, Gerd. Department of Management Science and Engineering, Stanford University
Dynamic Asset Allocation using Stochastic Programming and Stochastic Dynamic Programming - Models and Strategies
Only recently, the full dynamic and multi-dimensional nature of the asset allocation problem has been captured through applications of dynamic programming and stochastic programming techniques. The talk reviews the different approaches to dynamic asset allocation, presents a novel approach based on a dynamic programming recursion that permits to consider many rebalancing periods many asset classes and general classes of utility functions, and demonstrates how in practice dynamic asset allocation leads to superior results compared to static or myopic techniques. The implications of different utility functions and risk measures on the resulting optimal dynamic strategies are evaluated and examples are presented.
(ThA, South Ballroom)

Jofre, Alejandro. CMM & DIM, Universidad de Chile
A Stochastic Optimization- Noncooperative Game Problem: Electricity
In this work we model an electricity market with generators and customers located in a Network as a stochastic optimization/noncooperative two stage game problem. The generators are allowed to bid cost functions and are dispatched by a system operator which maximizes the total benefit while considering the electricity network constraints. We study analytical properties of this model and prove that a Perfect Nash equilibrium exists and is robust by using stability concepts derived from Variational Analysis.
(TA, Catalina)

Johnson, Anne. Dept. of Systems and Industrial Engineering, University of Arizona
Integrated Enterprise Modeling
Many large organizations must balance numerous complex subsystems to optimize a single overall objective, usually maximum profit. When each subsystem requires an intricate, time-consuming solution technique, these enterprises often resort to sequential planning, which yields a good but suboptimal solution. We propose an integrated modeling technique that may lead to a better overall solution than sequential methods, and demonstrate the paradigm with the airline schedule planning problem.

We first develop an integer program to find an airline schedule that meets demand as much as possible on a specified network of cities. We present surrogate models to approximate the cost contribution of each subsystem, including maintenance, crew scheduling, and revenue generation. The surrogates are linear programs that can be solved much more rapidly than the full models for the subsystems, but that provide a good indication of relative cost or feasibility of the approximated system. System variability is included in the subproblem data to improve the robustness of the overall schedule to disruptions. We use

decomposition methods to solve the scheduling problem, with the flight schedule IP as the master problem and each surrogate as a cut-generating subproblem. This method produces a maximally profitable schedule which planners can then insert in the full subsystem models to generate the details required for implementation. Computational and solution validation issues will be discussed.
(TD, Catalina)

· Higle, Julia L., Dept. of Systems and Industrial Engineering, University of Arizona

Kallio, Markku. Helsinki School of Economics
Currency hedging for a multi-national firm
This paper develops a multi-stage optimization model aiding the CFO of a global company in currency hedging. While the centralized cash management concerns several major currencies, our pilot model deals with USD and EUR only, the latter one being the base currency. A VEqC model is developed for modeling the exchange rate and interest rates of USD and EUR. Additionally, there is uncertainty in revenues over a twelve month planning horizon. Besides transaction risks related to revenues and expenditures, translation risk of share capital in foreign subsidiaries needs to be hedged. Currency positions (long and short), forwards, swaps and options are available for hedging. To find a desirable hedging strategy, alternative objectives and hedging policy constraints are considered. Numerical tests illustrate the performance of hedging strategies as well as practical considerations for model implementation. Sensitivity analysis is provided by out-of-sample tests and by error measures concerning possible misspecification of the equilibrium exchange rate in the VEqC model.
(FB, Catalina)

· Koivu, Matti, Helsinki School of Economics
· Pennanen, Teemu, Helsinki School of Economics

Kankova, Vlasta. Institute of Information Theory and Automation, Academy of Sciences of the Czech Republic
A Remark on Approximation and Decomposition in Multistage Stochastic Programs
Multistage ($M+1$–stage; $M \geq 1$) stochastic programming problems correspond to applications that can be considered with respect to a finite "discrete time interval and that can be simultaneously decomposed into individual time points. Multistage stochastic programs depend on an unneglected random element and the control of the corresponding activity is considered with respect to the mathematical expectation of the objective function. A constraints set can generally depend on the probability measure.

Two different (based) types of definitions of the multistage problems are known from the literature. A general multistage stochastic programming problem can be introduced either as an optimization problem considered with respect to some abstract mathematical space or as a finite system of parametric optimization problems considered with respect to the Euclidean space with an inner (recurrent) type of dependence and mathematical (mostly conditional) expectation in the objective functions of the individual problems. It is known that mostly a numerical treatment with these type of the problems is very complicated and, consequently, the multistage problems are very often solved by discretization (by scenario approach). However, to any "reasonable" approximation a stability (w.r.t. probability measures space) and a behavior of statistical estimates must be investigated.

Employing the second type of the definition the corresponding results on the stability and empirical estimates (for the multistage case) can be obtained on the basis of already achieved results for one–stage problems. However to this end, the individual objective functions (corresponding to the decomposed problems) must have suitable properties. The aim of the talk is to introduce assumptions under which the corresponding conditions are fulfilled. We introduce the assumptions under which the individual objective functions are not only continuous, convex and Lipschitz, but we introduce also suitable assumptions for possibility to employ the results of the large deviation and the central limit theorem. Furthermore, the corresponding approximate schemes will be mentioned. Special attention will be paid to the Markov type of dependence and to the autoregressive sequences.

(TA, Rincon)

· Smid, Martin, Institute of Information Theory and Automation, Academy of Sciences of the Czech Republic

Karabuk, Suleyman. University of Oklahoma
A dual resource production planning problem under uncertainty
We consider a production system which consists of two types of machines and which outputs a number of final products. The level-one machines produce an intermediate product that is input to the level-two machines, which in turn produce the final products. The final products that require the same intermediate product are grouped into the same product family. A level-one machine can be configured, at a significant cost, to produce any product family and its production can be used for any final product under the same family. Similarly, level-two machines require an expensive changeover for each different product they produce. The production-planning problem consists of finding the configuration of both machine types and the number of level-two machines that produce over the planning horizon such that demand for each final product at each period is satisfied and the total of changeover and inventory carrying costs are minimized. Any machine can be kept idle in one or more periods without changing configuration to avoid frequent changeovers. The limited availability of both machine types and the coordination requirements create a difficult combinatorial problem. This problem is further complicated by the demand uncertainty that the final products face.

We formulate the above-mentioned problem as a multistage stochastic programming model with integer recourse based on a scenario tree to describe demand uncertainty. We consider the configuration of the level-one machines through the planning horizon as here and now decisions and the configuration of level-two machines together with the number of level-two machines to produce as recourse decisions that are to be made as uncertainty reveals at each node of the scenario tree.

We apply a two-stage nested decomposition approach to solve the problem. Stage one master problem constitutes the configuration of level-one machines and captures their changeover cost. The subproblem constitutes all the recourse decisions through the planning horizon and captures the expected changeover costs for level-two machines and expected inventory carrying costs. The subproblem is decomposed into smaller product family problems, which are in turn solved by a two-stage decomposition algorithm. The master problem at this level constitutes the configuration of level-two machines and captures the expected changeover costs and the subproblem consists of the production schedule that captures the expected inventory carrying costs. First, we develop an efficient enumeration algorithm that solves the innermost subproblems for a given level-one and level-two machine configuration. The solution generated by the enumeration algorithm minimizes both the expected inventory carrying costs and the expected capacity shortfall. We use this feature to constrain expected capacity shortfall without additional computational burden. Next, we develop linear feasibility and optimality cuts that are heuristic in nature and analyze their empirical behavior on a real life problem. Finally, we apply the algorithm to solve a yarn production-planning problem we have observed at a US textile manufacturer and report our computational results.
(TF, Catalina)

Kaul, Hemanshu. Dept. of Mathematics, University of Illinois at Urbana-Champaign
Global Optima Results for the Kauffman NK Model
Many scenarios in theoretical biology, physics, and management science can be modeled as systems with several interacting components that can be in various states. The aim is to maximize a performance measure involving contributions from each component. This measure may depend on both the state of each component and on interactions between components. In 1987, Kauffman and Levin introduced a stochastic combinatorial optimization model for such systems, called the Kauffman NK model, where N is the number of components of the system and K measures the interaction between the components. This was proposed to model the evolution of genomes in theoretical biology but has since been applied in other areas as listed above.

Previous research on the NK model has emphasized simulations and analysis of local optima. Here we focus on rigorous results for global optima. We describe a computational setup using a stochastic network model, which leads to applicable strategies for computing bounds on global optima when K is small or is close to N. Recent papers used tools from analysis and probability to obtain bounds on the expected value of the global optima for fixed K and large N. We present bounds when K grows with N, using elementary probabilistic combinatorics and order statistics. We use a 'dependency' graph to convert the problem of bounding order statistics of dependent random variables into that of independent random variables while incorporating quantitative information about mutual dependencies among the underlying random variables. If time permits, an alternate upper bound and the analysis for the cases of underlying uniform and normal distributions will also be outlined.
(WA, Rincon)

· Jacobson, Sheldon, University of Illinois at Urbana-Champaign

Kaustuv. Stanford University
A Collaborative Optimization Algorithm for Stochastic Stackelberg-Nash games
A feature common to many large problems is they are composed of a collection is weakly connected small problems. Such problems, for example, arise in the design of aircraft or automobiles. While optimizing such systems, this weak coupling shows up either in the form of a few variables that arise in the state of all the subsystems, or in the form of a few constraints that connect the subsystems. We term the first as Optimization Problems with Global Variables (OPGV) and the second are called Optimization Problems with Global Constraints (OPGC). Under assumptions of non-degeneracy DeMiguel and Murray proposed locally convergent bilevel (decomposition) algorithms to solve OPGV and OPGC that are non-convex. They refer to their algorithms as collaborative optimization (CO). We show that stochastic Stackelberg-Nash games, which are viewed by many as difficult to solve, may be posed as an OPGV. Here each agent may be considered a subsystem. We show convergence of the CO algorithm for this problem and report preliminary numerical results. In general any stochastic program using a scenario tree may be viewed as an OPGV in which the subsystems are decision nodes in the scenario tree and the coupling variables are the decisions vectors at each of these nodes. Consequently, the CO algorithms may be applied. We shall show that Stackelberg-Nash games may be viewed as stochastic programs incorporating a scenario tree.
(TA, Catalina)

· Murray, Walter, Stanford University
· Shanbhag, Uday V., Stanford University

Kim, Sujin. Cornell University
Adaptive Control Variates
Adaptive Monte Carlo methods are specialized Monte Carlo simulation techniques where the methods are adaptively tuned as the simulation progresses. The primary focus of such techniques has been in adaptively tuning importance sampling distributions to reduce the variance of an estimator. We instead focus on adaptive control variate schemes, developing asymptotic theory for the performance of two adaptive control variate estimators. The first estimator is based on a stochastic approximation scheme for identifying the optimal choice of control variate. It is easily implemented, but its performance is sensitive to certain tuning parameters, the selection of which is nontrivial. The second estimator uses a sample average approximation approach. It has the advantage that it does not require any tuning parameters, but does require the availability of nonlinear optimization software.
(ThA, Rincon)

· Henderson, Shane, Cornell University

King, Alan. IBM Research, Yorktown Heights NJ
Managing Supply Contracts for Custom Manufactured Items with Long Production Lead Times
We consider the problem faced by a supplier of custom products. Due to long production leadtimes, the supplier must produce to customer forecast rather than wait for firm orders. The supplier is thus exposed to the risk of excess production because the majority of these products have no salvage value. We propose a mathematical model for the supplier's choices in the presence of a program that defines the supplier's and customers' obligations, with the goal of managing the supplier's risk.
(TF, Catalina)

· Heching, Aliza, IBM TJ Watson Research, Yorktown Heights NJ.

Klein Haneveld, Willem K. University of Groningen
Asset Liability Management modeling using multistage mixed-integer Stochastic Programming
A pension fund has to match the portfolio of long-term liabilities with the portfolio of assets. Key instruments in strategic Asset Liability Management are the adjustments of the contribution rate of the sponsor and the reallocation of the investments in several asset classes at various points of time. We formulate a multistage mixed-integer stochastic program to model this ALM decision proces. Special attention is paid to flexible risk measures, representing the interests of parties involved. Binary variables are introduced as indicators of risky events, and used in a soft constraint setting. Integrated chance constraints are used as hard constraints for next year's risks. The approach reflects new rules of the Dutch supervisor.
(TC, South Ballroom)

· Drijver, Sibrand J, University of Groningen
· van der Vlerk, Maarten H, University of Groningen

Kleywegt, Anton. Georgia Institute of Technology
Derivative Free Algorithms for Stochastic Optimization
Consider a stochastic optimization problem $\min_x\{f(x) \equiv E_\omega[F(x,\omega)]\}$. Suppose that the following hold:

1. It is very hard to compute $E_\omega[F(x,\omega)]$ exactly for a given value of x.
2. It is relatively easy to compute $F(x,\omega)$ exactly for a given value of (x,ω).
3. The objective function f is smooth, but it is very hard to compute the derivative $f'(x)$ exactly for a given value of x.
4. The function $F(\cdot,\omega)$ is Lipschitz continuous for each ω, but even if $F(\cdot,\omega)$ is differentiable at a given value of (x,ω), it requires a lot of effort to compute the derivative.

This work was motivated by a revenue management application in which $F(x,\omega)$ is evaluated by running a fairly complicated simulation. We consider a class of algorithms for such optimization problems that approximate the objective function f, for example with a sample average approximation. Local approximations of the objective function are constructed with response surface methods. The local approximations are used in ways that are similar to the ways in which traditional nonlinear programming algorithms use local approximations obtained with derivatives. We show the convergence of a variety of such algorithms that have been suitably modified to use approximations of the objective function. We present computational results for problems from the CUTE test set for a trust region algorithm that was developed to solve such problems, while we aim to use only a small number of evaluations of $F(x,\omega)$.
(MF, Rincon)

· Bharadwaj, Vijay, Georgia Institute of Technology

Koivu, Matti. Helsinki School of Economics
Integration quadratures in discretization of stochastic programs
Monte Carlo (MC) has become the most popular method for constructing numerically solvable approximations of stochastic programs. However, certain modern integration quadratures are often superior to crude MC in high-dimensional integration, so it seems natural to try to use them also in discretization of stochastic programs.

We give conditions for epi-convergence of discretizations obtained via integration quadratures. Our result is closely related to some of the existing ones, but it is easier to apply to discretizations and it allows the feasible set to depend on the probability measure, i.e. complete recourse is not required.

As examples, we prove epi-convergence of quadrature-based discretizations of certain models of portfolio management and we study their behavior numerically. Besides MC, our discretizations are the only existing ones with guaranteed epi-convergence for these problem classes. In our tests, modern quadratures clearly outperform crude MC.
(ThF, Rincon)

· Pennanen, Teemu, Helsinki School of Economics

Kong, Nan. University of Pittsburgh
Two-Stage Integer Programs with Stochastic Right-Hand Sides: A Superadditive Dual Approach
We consider the following two-stage stochastic pure integer programs in which the uncertainty only appears in the second-stage right-hand sides; there are a finite number of scenarios that are discretely distributed; and all components in the problem are nonnegative and integral. We present an algorithmic framework to solve the above problems via an equivalent superadditive dual formulation. With this reformulation, we divide the solution procedure into two phases. In phase I of the solution procedure, we exploit some properties of integer programs and give two algorithms to find the first- and second-stage value functions defined over an enormous number of right-hand sides. In phase II, we implicitly search the "tender space" constructed through the reformulation. In phase I of the solution procedure, we first present an IP-based algorithm in which we maintain a lower bound and an upper bound of the value function. At each iteration, the algorithm updates the bounding functions in terms of some right-hand sides following three operations: 1. solve an integer program with some right-hand side; 2. given an optimal solution for some right-hand side, apply the integer complementary slackness property; 3. apply the nondecreasing and superadditivity properties. The algorithm terminates when two bounding functions are equal for all considered right-hand sides. This algorithm applies even when some of the nonnegativity and integrality restrictions are lifted. We also present a DP-based algorithm, motivated by Gimore and Gomory's dynamic programming recursion for the knapsack problem, as a simplification of the first algorithm. This algorithm only defines the lower bound function and applies an alternative termination condition. In phase II of the solution procedure, we develop a global branch-and-bound approach and a level-set approach to find an optimal tender. With the proposed global branch-and-bound approach, the tender set is partitioned into hyper-rectangles. Easily computable bounds are designed. For the level-set approach, we introduce the concept of minimal tenders and show that there exists an optimal tender that is a minimal tender. Therefore, we can search for an optimal tender in this reduced search space. We present a special case in which the minimal tender set can be identified analytically. We also discuss a method to construct an integral monoid, which is a superset of the minimal tender set, for general cases without knowing the entire first-stage value function. Finally, we provide an even smaller superadditive dual reformulation in which some first-stage decision variables can be eliminated once the value function is partially obtained. We test our method on several instances generated by our random instance generation scheme. With our computational results, we show that our method can solve randomly generated instances that are several orders of magnitude larger than those found in the literature.
(MF, Rincon)

· Hunsaker, Brady, University of Pittsburgh
· Schaefer, Andrew, University of Pittsburgh

Kouwenberg, Roy. Asian Institute of Technology
A Primal-Dual Decomposition Algorithm for Multistage Stochastic Convex Programming
This paper presents a new and high performance solution method for multistage stochastic convex programming. Stochastic programming is a quantitative tool developed in the field of optimization to cope with the problem of decision-making under uncertainty. Among others, stochastic programming has found many applications in finance, such as asset-liability and bond-portfolio management. However, many stochastic programming applications still remain computationally intractable because of their overwhelming dimensionality. In this paper we propose a new decomposition algorithm for multistage stochastic programming with a convex objective and stochastic recourse matrices, based on the path-following interior point method combined with the homogeneous self-dual embedding technique. Our preliminary numerical experiments show that this approach is very promising in many ways for solving generic multistage stochastic programming, including its superiority in terms of numerical efficiency, as well as the flexibility in testing and analyzing the model.
(FB, Rincon)

Kristjansson, Bjarni. Maximal Software, Inc.
Introducing SPInE Stochastic Extensions for the MPL Modeling System
We will present an implementation of stochastic extensions for the MPL Modeling System, called MPL/SPInE. This work results from collaboration between Brunel University, OptiRisk Systems and Maximal Software. MPL/SPInE supports scenario based recourse problems and handles both two-stage and multi-stage problems. Several formulations of stochastic models in MPL will be demonstrated and solved, including manufacturing, power system, and asset liability management models.
(WA, Catalina)

· Valente, Patrick, OptiRisk Systems

Krokhmal, Pavlo. University of Florida
On Risk Measures in Stochastic Programming
We consider a generalization of the classical two-stage stochastic programming model that captures the risk of the second-stage (recourse) action. The consequential properties of the formulated stochastic programming problem are discussed. We introduce several general representation forms for coherent risk measures that facilitate incorporation of risk measures into stochastic programs. Applicability of the existing algorithms for solving the formulated SP problem is discussed, and numerical examples are presented.
(TC, South Ballroom)

Kuhn, Daniel. University of St. Gallen, Institute for Operations Research and Computational Finance
Generalized Bounds for Convex Multistage Stochastic Programs
In this talk we investigate convex multistage stochastic programs whose objective and constraint functions exhibit a generalized nonconvex dependence on the random parameters. Although the classical Jensen and Edmundson-Madansky type bounds or their extensions are generally not available for such problems, tight bounds can systematically be constructed under mild regularity conditions. A distinct primal-dual symmetry property is revealed when the proposed bounding method is applied to linear stochastic programs. Exemplary applications are studied to assess the performance of the theoretical concepts in situations of practical relevance. It is shown how market power, lognormal stochastic processes, and risk-aversion can be properly handled in a stochastic programming framework. Numerical experiments show that the relative gap between the bounds can typically be reduced to a few percent at reasonable problem dimensions.
(FB, Rincon)

Lai, Bogumila. St. Joseph's College
Dual Methods for Probabilistic Optimization Problems
We consider nonlinear stochastic optimization problems with probabilistic constraints. The concept of a

p-efficient point of a probability distribution is used to derive equivalent problem formulations. We analyze a Lagrange relaxation of the problem, the dual functional and its subdifferential., and derive necessary and sufficient optimality conditions. We use the analysis to develop two algorithms for solving the dual problem. The algorithms are based on cutting plane techniques for approximation of the dual functional and the p-efficient frontier. The algorithms yield an optimal solution for problems involving r-concave probability distributions. For general probability distributions the algorithms provide an optimal solution of the convexified problem, and a suboptimal solution of the original problem, as well as upper and lower bounds for the optimal value of the original optimization problem The results are applied to solve a bond portfolio problem with probabilistic liquidity constraint. Numerical illustration is provided which demonstrates the numerical efficiency of the methods. This is a joint work with Darinka Dentcheva, Stevens Institute of Technology, and Andrzej Ruszczynski, Rutgers University.
(FA, Catalina)

· Dentcheva, Darinka, Stevens Institute of Technology
· Ruszczynski, Andrzej, Rutgers University

Leyland, Geoff. University of Auckland
Stochastic Optimization: Rowing to Barbados
On the 19th of October 2003, 16 rowing boats set out from La Gomera in the Canary Islands, and headed for Port Charles in Barbados, some two and a half thousand nautical miles away. 40 days, 5 hours and 31 minutes later, Team Holiday Shoppe—Kevin Biggar and Jamie Fitzgerald—crossed the finish line, winning the race and setting a new world record. A key ingredient in the team's success was a set of routing charts developed by the authors using stochastic optimization techniques. These charts not only helped the Team with their strategic and day-to-day route planning, they also proved vital in the Team's successful defense against the second-place finisher's official protest, which complained that Team Holiday Shoppe was too fast. This paper tells the story of Team Holiday Shoppe's journey, and the role that stochastic optimization played in the Team's success.
(TC, Rincon)

· Philpott, Andrew, University of Auckland

Linderoth, Jeff. Lehigh University
Multistage Stochastic Linear Programming on a Computational Grid
We will describe an implementation of a nested-decomposition-based, multi-stage stochastic linear programming solver running on a computing platform known as a computational grid. Computational results revealing the power of the approach and the platform will be presented.
(WC, South Ballroom)

· Shen, Jerry, Lehigh University

Lisser, Abdel. Universitė de Paris Sud
Stochastic Frequency Assignment Problem
Frequency Assignment Problem (FAP) is central for design of modern mobile networks. These networks partition a given geographical area into *cells* with a *base station* attached to each cell. The purpose of the base station is to exchange calls between the users that are currently present at the cell and the rest of the network. The calls are carried by a fixed amount of radio frequencies. The total amount of admissible frequencies is limited and they are a scarce resource. The FAP consists of assignment of frequencies between cells with the purpose of meeting communication demand and assuring an admissible quality of service by minimizing the radio interference which degrade significantly the quality of service. The problem is complicated by additional constraints which prohibit assignment of close frequencies to the same cell and to adjacent cells because such assignment causes serious radio interference between calls. FAP is very difficult quadratic optimization problem in binary variables. Usually this problem is solved in deterministic setting assuming that communication demand is deterministic. However, this is a very inadequate

assumption because demand has daily, weakly and seasonal changing patterns with additional demand changes due to evolution of services and user preferences. Besides, interference between frequencies in different cells is also uncertain. Introduction of uncertainty into FAP leads to quadratic stochastic programming problem in binary variables which is not solvable by exact methods in most practical cases. In this paper we formulate several stochastic programming problems which model stochastic FAP and utilize semi-definite programming (SDP) relaxations to derive bounds for its solution. Two ways are explored: application of SDP relaxation to deterministic equivalent of stochastic FAP and utilization of SDP relaxations for solution of master problem within the Benders decomposition framework. Our experience suggests that SDP is a useful tool for solving stochastic FAP.
(ThD, Rincon)

· Benajam, Wadie, Université de Paris Sud
· Gaivoronski, Alexei, Norwegian University of Science and Technology

Liu, Tongyin. RUTCOR, Rutgers Center for Operations Research
P-Efficient Points in Design of Stochastic Networks
In the design of a transportation network of cooperating power system, or hydrological network, usually a real-valued random variable is associated with determining the demand at each node. To guarantee there exists a feasible flow in this network with some prescribed probability $p \in (0,\ 1)$ and minimize the cost of building such a network, a stochastic programming problem is formulated in this paper. To solve the problem in the case of discrete distributions of random variables, the concept of p-level efficient points are used to a system of linear inequalities involving the demand and the arc capacity functions which can be obtained by the Theorem of Gale and Hoffman to have a feasible flow. By using an elimination method introduced by Prékopa and Boros, we get a reduced system of linear inequalities, and new p-level efficient points are usually not the simple projection of the old ones. Then the relation between the p-level efficient points are studied. The results are illustrated with numerical examples of designing stochastic networks.
(ThD, Rincon)

· Prékopa, Andras, RUTCOR, Rutgers Center for Operations Research

Liu, Yu-Hsin. National Chi-Nan University, Taiwan
The sample average approximation method for multinomial probit model estimation
The study of decision-makers' choice behavior in a dynamic context has gained significant attention in the past decade. The multinomial probit (MNP) model, in which the error terms are jointly multivariate normal distributed with zero mean and a general variance-covariance matrix, provides mathematical representations of discrete choice situations that can incorporate alternative behavioral theories, such as utility maximization and bounded rationality. With a general variance-covariance structure, the MNP model can capture dynamic aspects of decision-makers' choice behavior, including state dependence, serial and contemporaneous correlation, as well as random taste variation. However, no closed form solution exists for the MNP choice probability, which is given by a multidimensional integral of the multivariate normal density function. To ameliorate such difficulties, early MNP estimation procedures used to rely on numerical approximations, such as Clark's approximation to evaluate the MNP choice probabilities. Though Clark's approximation is quite efficient computationally, its accuracy becomes questionable when the dimension of the integral is more than 4 or 5 alternatives and in cases where the variables have very different variances and similar means. To enhance the accuracy of the MNP probability calculation, Monte-Carlo simulation has recently been used to estimate the value of MNP choice probability. For the past few years, several studies have tried to solve maximum likelihood estimation in MNP model using Monte-Carlo simulation for MNP choice probability calculation. The fundamental problem with this kind of application is that they treated maximum likelihood estimation in MNP model as a nonlinear programming problem. Considering that Monte-Carlo simulation yields different values of MNP probability with different random draws, the MNP probability should be more suitably treated as a random variable whereas the maximum likelihood estimation in MNP model as a stochastic programming problem. Bearing this in mind, this paper focused on testing three different optimization methods – nonlinear programming,

incorporating genetic algorithm and nonlinear programming, as well as scatter search, to solve the stochastic programming problem (i.e., maximum likelihood estimation for MNP model) using the sample average approximation (SAA) method. A set of numerical experiments, based on synthetic data sets with known model specifications and error structures, were conducted to compare the effectiveness and efficiency among these three proposed optimization methods. The preliminary results indicated that the scatter search outperformed the other two optimization techniques in terms of log-likelihood function value and computing efficiency.
(MF, Rincon)

Lium, Arnt-Gunnar. Molde University College
Stochastic service network design
Traditionally, deterministic models are used for service network design, despite the understanding that the underlying demand is stochastic. This talk reports ongoing investigations into the effects of including stochastics into the design itself. We are interested in how the optimal solution changes from the deterministic to the stochastic model, but also how aspects of the stochastics, such as co-variation, affect the optimal design.
(ThD, Rincon)

· Crainic, Teodor Gabriel, University of Quebec at Montreal
· Wallace, Stein W., Molde University College, Norway

Lopes, Leo. University of Arizona
Computational Experiments With a Dynamic Scenario Genaration Algorithm
To build tractable Scenario Trees one must typically discretize continuous random variables and aggregate discrete random variables. This is usually done before solving. In this case, the goal is to generate a scenario tree with desirable statistical properties. However, this approach can not benefit from information regarding the impact of a specific scenario on the objective. Casey and Sen have developed an algorithm that uses prolongations to dynamically refine a Scenario Tree as a problem is being solved. We report on computational experiments using that algorithm. We experiment with different rules and variations on the algorithm in order to produce scenario trees containing especially important sequences of events that might warrant further examination.
(ThA, Catalina)

· Casey, Michael, University of Puget Sound
· Sen, Suvrajeet, University of Arizona

Lucas, Cormac. Brunel University
Treasury Management Model with Foreign Exchange
In this paper we formulate a model for foreign exchange exposure management and (international) cash management taking into consideration random fluctuations of exchange rates. A vector error correction model (VECM) is used to predict the random behaviour of the forward as well as spot rates connecting dollar and sterling. A two-stage stochastic ogramming (TWOSP) decision model is formulated using these random parameter values. This model computes currency hedging strategies, which provide rolling decisions of how much forward contracts should be bought and how much should be liquidated. The model decisions are investigated through ex post simulation and backtesting in which value at risk aR) for alternative decisions are computed. The investigation (a) shows that there is a considerable improvement to "spot only" strategy, (b) provides insight into how these decisions are made and c) also validates the performance of this model.
(FB, Catalina)

· Mitra, Gautam, Brunel University
· Spagnolo, Fabio, Brunel University
· Voslov, Konstantin, Brunel University

Løkketangen, Arne. Molde University College
Solving a Dynamic and Stochastic Vehicle Routing Problem with a Sample Scenario Hedging Heuristic
The statement of the standard Vehicle Routing Problem (VRP) cannot always capture all aspects of real-world applications. As a result, extensions or modifications to the model are warranted. Here we consider the case when customers can call in orders during the daily operations, i.e., both customer locations and demands may be unknown in advance. This is modelled as a combined dynamic and stochastic programming problem, and a heuristic solution method is developed where sample scenarios are generated, solved heuristically, and combined iteratively to form a solution to the overall problem.
(TC, Rincon)

· Hvattum, Lars Magnus, Molde University College
· Laporte, Gilbert, HEC Montreal

MacLean, Leonard. School of Business Administration, Dalhousie University
Risk Control in a Speculative Financial Market
In a financial market with long term stability, the exhuberance generated by excess returns on investment can lead to a price bubble, where stocks are overvalued. Inevitably, there is a large market correction, and the speculative investor can suffer great losses. An approach to controlling the risk from overvaluation of stocks is presented in this paper. A dynamic pricing model with a shock term provides the framework. The methodology involves upper and lower control limits on the trajectory of accumulated capital. The limits correspond to levels where the returns deviate significantly from expectations, and a shock is imminent. The methods are applied stock and bond returns covering the technology bubble.
(ThF, Catalina)

· Consigli, Giorgio, University of Bergamo
· Ziemba, William T., Sauder School of Business, University of British Columbia

Mayer, Janos. IOR University of Zurich
Recent developments concerning SLP-IOR
The purpose of the lecture is to provide an overview on recent developments regarding SLP–IOR, our model management system for stochastic linear programming. The scope of the system has been extended by implementing several additional model classes. These include multistage recourse problems, integrated chance constraints and CVaR constraints. For multistage recourse problems the central issue is dealing with scenario trees. In the current version these can be built and the attached data can be edited via a graphical user interface. Two scenario generation techniques are implemented: conditional sampling and the moment–matching technique of Høyland, Kaut, and Wallace. Both separate and integrated chance constraints are available in the present version, as well as Conditional Value–at–Risk (CVaR) constraints. Besides in the set of constraints, stochastic linear programming models involving these functions in the objective are also available. Further developments include: the sample–average approximation (SAA) method has been added for two–stage recourse problems, the analyze facilities have been enhanced, and several alternative LP formulations have been provided for recourse problems. In the lecture we consider the newly added model classes from the model management point of view and discuss the implications on the overall system design. For illustrating the computational capabilities of SLP–IOR, we also present some computational results involving several stochastic linear programming model classes.
(WA, Catalina)

· Kall, Peter, IOR University of Zurich

Mitra, Gautam. CARISMA, Brunel University, UK
Stochastic Programming and Scenario Generation within a Simulation Framework : An Information Systems Perspective
Stochastic Programming brings together models of optimum resource allocation and models of randomness to create a robust decision making framework. The models of randomness with their finite, discrete

realisations are called Scenario Generators. We present the role of such a tool within the context of a combined information and decision support system. We analyse the features of decision models and descriptive models, and examine how these can be integrated with data marts of analytic organisational data and decisions data. Recent developments in On-Line Analytical Processing tools and multidimensional data viewing are taken into consideration. We give illustrative examples of optimisation, simulation and results analysis to explain our multifaceted view of modelling.
(WC, South Ballroom)

· Birbilis, George, CARISMA, Brunel University, UK
· Di Dominica, Nico, CARISMA, Brunel University, UK
· Valente, Patrick, CARISMA, Brunel University, UK

Moriggia, Vittorio. University of Bergamo
Calibrating option implied trees
The calibration of Muzzioli-Torricelli model (2002) requires solving a non-linear programming problem. The calibrated tree describes the evolution of the underlying security according to option prices available in the market. This tree fits the market's expectations and can be useful in path-dependent derivatives pricing. The aim of this paper is to compare two different sources of stochasticity of the model: the volatility smile and the volatility surface.
(ThD, South Ballroom)

· Muzzioli, Silvia, University of Modena and Reggi
· Torricelli, Costanza, University of Modena and Reggi

Morton, David. University of Texas at Austin
Assessing Policy Quality in Multi-stage Stochastic Programming
Solving a multi-stage stochastic program with a large number of scenarios and a moderate-to-large number of stages can be computationally challenging. We develop two Monte Carlo-based methods that exploit special structures to generate feasible policies. To establish the quality of a given policy, we employ a Monte Carlo-based lower bound (for minimization problems) and use it to construct a confidence interval on the policy's optimality gap. The confidence interval can be formed in a number of ways depending on how the expected solution value of the policy is estimated and combined with the lower-bound estimator. Computational results suggest that a confidence interval formed by a tree-based gap estimator may be an effective method for assessing policy quality. Variance reduction is achieved by using common random numbers in the gap estimator.
(ThF, South Ballroom)

· Chiralaksanakul, Anukal, Vanderbilt University

Mulvey, John. Princeton University
Managing Global Financial Companies via Decentralized Stochastic Programs
Global financial institutions continue to consolidate through mergers and acquisitions. Traditional risk management methods such as RAROC misestimate the extreme risks for the merged enterprise, thus reducing risk-adjusted profits. We develop an enterprise risk management system based on a stochastic program. The SP can be solved directly for well focused institutions, such as re-insurance companies, or by means of a decentralized approach for global institutions possessing diverse operations. A real-world example depicts the advantages of the approach over current risk management practice. State prices, for example, are directly accessible.
(WA, South Ballroom)

· Erkan, Hafize, Princeton University

Möller, Andris. Humboldt-University Berlin

An Application of Scenario Tree Based Stochastic to Airline Revenue Management

O&D revenue management (RM) has become a standard in the airline industry. In this paper, we present an approach to O&D RM which does not make assumptions on the underlying demand distributions. Protection levels are determined for all origin destination itineraries, fare classes, points of sale and data collection points (DCPs), and for a variety of demand patterns over the complete booking period. This approach to the seat inventory problem is modelled as a multistage stochastic program, where its stages correspond to the DCPs of the booking horizon. The stochastic passenger demand process is approximated by a scenario tree generated from resamples of adjusted historical data by a recursive scenario reduction procedure. The stochastic program represents a specially structured large scale LP that may be solved by standard LP software (e.g. CPLEX). Numerical experience will be reported.
(ThC, South Ballroom)

· Römisch, Werner, Humboldt-University Berlin
· Weber, Klaus, Lufthansa Systems

Nemhauser, George L.. Georgia Insitute of Technology

Polyhedral Stochastic Integer Programming

We give a procedure for obtaining new valid inequalities for a 0-1 mixed-integer program (MIP) by combining known valid inequalities. Although the procedure can be applied to any 0-1 MIP, it is particularly useful for multi-stage stochastic 0-1 MIPs. Here we show how to combine valid inequalities from individual scenarios (deterministic instances) to obtain new inequalities that are valid for the scenario tree. We then illustrate the procedure by developing inequalities for the stochastic uncapacitated lot-sizing problem and a stochastic knapsack problem.
(MD, South Ballroom)

· Ahmed, Shabbir, Georgia Institute of Technology
· Guan, Yongpei, Georgia Institute of Technology

Nowak, Matthias. SINTEF

Scenario selection by dual preference

This paper presents an algorithm for selecting scenarios in order to build a scenario tree. It starts with an empirical distribution with many atoms that is given by a forecasting method and historical observations. Then, the Kantorovich-distances are calculated, which serve as costs for replacing one scenario by another. These distances and the probabilities of the scenarios are input to the selection algorithm.

During the dual iterations lagrange parameters are calculated that can be interpreted as incentives to include a certain scenario in scenario bundles. Often, a duality gap of zero is observed, otherwise dual preference is used in order to obtain a selection that is at least sub-optimal.

In our computer experiments non-zero duality gaps occured infrequently. The analysis of those cases implied that the number of selected scenarios was not properly chosen. Usually the gap was closed if the number of scenarios was increased or decreased.

The talk gives an outline of the algorithm, shows some observations and numerical results.
(ThA, Catalina)

Noyan, Nilay. RUTCOR- Rutgers Center for Operations Research

A Variant of the Hungarian Inventory Control Model

The term 'Hungarian inventory control model' refers to a model system initiated by Prékopa (1965) and Ziermann (1964), where the ordered amount is delivered in an interval, rather than at a designated time epoch according to some stochastic process and the consumption takes place in the same interval according to some other stochastic process. The problem is to determine the minimum level of initial safety stock that ensures the possibility of consumption, without disruption, in the whole time interval. The models in

this system have been primarily of static (single-stage) type. Recently Prékopa (2004) has shown that the interval type delivery and consumption processes can be combined with classical inventory models and also formulated a dynamic type (two-stage) model with such interval type processes and probabilistic constraints. In this paper we modify the assumptions of those models and formulate simpler, numerically more tractable models. We also discuss the computational aspects of our problems and present some numerical examples.
(WC, Rincon)

· Prékopa, Andras, RUTCOR- Rutgers Center for Operations Research

Ntaimo, Lewis. Dept. of Industrial Engineering, Texas A&M University
Disjunctive Decomposition for Stochastic Mixed-Integer Programming with Continuous First-Stage
The disjunctive decomposition (D^2) method for two-stage stochastic mixed-integer programming (SMIP) requires that the first-stage solutions be extreme points of the first-stage feasible set. In this talk an extension of the D^2 approach to SMIP problems where this requirement is not necessary will be given. In particular, a branch-and-cut method for two-stage SMIP with continuous first-stage is derived and its convergence proved. This approach is fairly unique in that branching is done on a continuous domain and is guided by the disjunction variables in the second-stage
(TF, South Ballroom)

Ostermaier, Georg. Institute for Operations Research and Computational Finance, University of St.Gallen, Switzerland
Derivation of water value distributions from multistage stochastic optimization of hydro power systems
We describe a multistage stochastic model that aims at the medium term optimization of a large-scale hydropower generation system with access to a spot market. Thereby, the impact of stochastic spot prices and reservoir inflows is the key aspect of investigation. First, we investigate to what extent decision making based on probabilistic spot price models increases the achievable profits. In addition, we study the influence on the water values, which are used by practitioners as important control variables for the dispatch of the system. In our mathematical model we consider a finite set of scenarios $\omega \in \Omega$ with $\omega = (\omega_0, \dots, \omega_T)$. The random vector ω_t observed at stage t comprises the electricity spot price η_t and the natural inflow $\xi_{r,t}$ to reservoir r for each $r = 1, \dots, R$. Denote by $P_{t\to T}(\omega)$ the residual profit in scenario ω from stage t to T under the optimal non-anticipative decision strategy. Then, the scenario-dependent water value for reservoir r at stage t is determined by the subdifferential of the profit $P_{t\to T}(\omega)$ with respect to $\xi_{r,t}$, keeping the decisions in stages 0 through $t-1$ fixed. The expected water value for some reservoir at stage 0 reduces to the dual variable of the corresponding reservoir balance equation in the root node of the stochastic program. Our numerical results demonstrate that adequate modelling of the spot prices as a stochastic process significantly impacts the achievable profit as well as the water value distributions. For some system topologies we observe counterintuitive narrowing of these distributions.
(MF, Catalina)

· Frauendorfer, Karl, Institute for Operations Research and Computational Finance, University of St.Gallen, Switzerland
· Kuhn, Daniel, University of St. Gallen, Institute for Operations Research and Computational Finance

Pan, Feng. Los Alamos National Laboratory
Network Interdiction of Nuclear Material Smuggling
We describe a stochastic network interdiction model for identifying locations for installing detectors sensitive to nuclear material. We propose single country and multi-country interdiction models. We provide solution techniques and present various test results. We describe some applications of our model to help strengthen the overall capability of preventing the illicit trafficking of nuclear materials
(MC, South Ballroom)

· Morton, David, The University of Texas at Austin

Pang, Jong-Shi. Department of Mathematical Sciences, Rensselaer Polytechnic Institute
On the global minimization of the Value-at-Risk
In this paper, we consider the nonconvex minimization problem of the value-at-risk (VaR) that arises from financial risk analysis. By considering this problem as a special linear program with linear complementarity constraints (a bilevel linear program to be more precise), we develop upper and lower bounds for the minimum VaR and show how the combined bounding procedures can be used to compute the latter value to global optimality. A numerical example is provided to illustrate the methodology. This is joint work with Sven Leyffer from Argonne National Laboratory.
(FB, South Ballroom)

Parija, Gyana. IBM Research
Strategic budgeting for wildfire management in the U.S.
We will present a stochastic IP model and an algorithm for optimizing the initial response (IR) organization needed to maximize the effectiveness of various fire containment activities. An initial response organization could consist of a set of hand crews, engines, bull-dozers, helicopters, and the like.
(TF, Rincon)

Pennanen, Teemu. Helsinki School of Economics
An analytical approach to stochastic programming
Analytical approaches to problem solving consist of two steps:

1 Modeling the problem,

2 Solving the model.
In stochastic programming (both in literature and in practice), modeling is often done only on a descriptive level where one never specifies the true model whose solution is sought. This is partly due to the fact that often all natural candidates for a true model are infinite-dimensional optimization problems involving mathematical concepts that practitioners are not always familiar with. Indeed, in many problems, there are essential (not just technical) features that can be captured only in terms of infinite-dimensional spaces. Such general stochastic programming models were well-developed already in the 1970's, but it seems that, as stochastic programming gained popularity among practitioners, they were partly forgotten. Nowadays, stochastic programming models of real-life problems are often formulated in terms of scenario trees constructed in an ad-hoc manner. This has resulted in vague formulations of stochastic programs that lack interpretation.

Our aim is to describe an analytical version of the stochastic programming approach for practical decision making. In our approach, both the modeling and solution phases are broken down into two sub-phases:

1.1 Modeling the decision problem as an optimization problem,

1.2 Modeling the uncertainty,

2.1 Discretization of the optimization problem,

2.2 Numerical solution of the discretized problem.
The first step consists of modeling the decision problem as a stochastic optimization problem over a general probability space. The second step consists of specifying the probability distribution of the uncertain data. The purpose of the third step is to construct finite-dimensional, numerically solvable, consistent approximations of the optimization model specified in the first two steps. The discretized model is then solved in the fourth step using appropriate techniques for stochastic programs over finite scenario trees.

This kind of approaches to problem solving are familiar from other fields of applied mathematics such as ordinary or partial differential equations. Indeed, there also one models real phenomena by infinite-dimensional models, after which solutions are sought through discretization and numerical computation. Our approach has several advantages. First, it facilitates the solution process by decomposing it into more easily manageable pieces. Second, having a well-defined model allows for rigorous analysis of the problem and solution techniques. Third, it allows one to use well-developed models from

various fields of stochastics where stochastic processes are not restricted to finite scenario trees. Fourth, this approach relates closely with other disciplines, making stochastic programming more attractive to a wider range of researchers and practitioners.
(ThE, Grand Ballroom)

Pflug, Georg. University of Vienna
Risk measures as solutions of stochastic programs
Practically all risk measures proposed in the literature can be seen as solutions of linear stochastic programs. This means that they have primal and dual representations, are monotone w.r.t. information and exhibit convexity properties. Also monotonicity properties may often be easily deduced from these representations.

We review representations of one- and multi-period risk measures and, following Kusuoka (2000), investigate special representations of risk measures which depend only on the distribution of the involved stochastic processes.
(MF, South Ballroom)

Philpott, Andy. University of Auckland
On unit commitment in electricity pool markets
We consider an electricity generator making offers of energy into an electricity pool market. The generator runs a set of generating units with given start-up costs and operating ranges. For a given time period, it must submit to the pool system operator a supply function, typically consisting of a fixed number of quantities of energy and prices at which it wants these dispatched. The amount of dispatch depends on the stack offered along with the offers of the other generators and market demand, both of which are random, but are assumed have known market distribution functions. After dispatch the generator determines which units to run to meet the dispatch. The generator seeks an offer stack that maximizes its expected profit. We describe an optimization procedure based on dynamic programming that can be used to construct optimal offer stacks in successive time periods over a fixed planning horizon (typically a single trading day).
(MF, Catalina)

· Schultz, Rüdiger, Institute of Mathematics, University Duisburg-Essen

Polivka, Jan. Charles University Prague
Sensitivity Analysis and Asymptotic Properties of Two-Stage Scenario Based Stochastic Programs
In stochastic programming models the modeler always faces problem how to approximate the true continuous distribution with a discrete one. One of frequently used scenario generation methods to solve this problem is based on fitting of moment conditions on marginal distributions and covariance (or correlation) matrix.

Here we developed, under additional assumptions on structure of scenario tree, the asymptotic properties of 2-stage stochastic programs. Necessary input is the asymptotic distribution of estimated moments. In the case of scenario based two-stage stochastic programs one might exploit classical stability results for non-linear programs employing fully the structure of the stochastic program. Viability of theory is presented on stylized facts example of a portfolio management problem.

It is possible to obtain derivatives of the optimal solution and of the optimal objective of the stochastic program and to construct confidence intervals. The presented approach provides another insight into sensitivity behavior of 2-stage scenario based stochastic programs than the common numerical evaluations based solely on back-testing and out-of-sample analysis.
(ThC, Rincon)

· Dupačová, Jitka, Charles University

Poojari, Chandra. CARISMA; Bunel University, UK
Scalability and implementation issues in stochastic programming algorithms
We present an overview of the current progress in solving stochastic programming problems and discuss the leading algorithmic research issues processing two-stage and multi-stage SP problems. Using industrial models and benchmark models from the library of SP test problems, we compare the performances of two such methods - Benders decomposition and stochastic decomposition. We discuss the computational advantages of parallelization and warm starts which are necessary to achieve scale up in processing large instances of practical problems
(ThD, Catalina)

· Ellison, Frank, CARISMA, Brunel University, UK
· Mitra, Gautam, CARISMA, Brunel University, UK

Popela, Pavel. Department of Mathematics, Brno
Comparison of Scenario Modifications in Melt Control
The purpose of the paper is to present and discuss the experience collected during modeling and solving melt control problems by scenario-based stochastic programs. From previous studies, it is known that melt control in foundry can be modeled by stochastic programming. In the related models, historical data based on melt reports may be advantageously used to derive necessary scenarios. Thus, several known techniques have been applied and tested to obtain suitable scenarios. In fact, the amount of data available may be huge and the extraction of only the most useful information may be needed. So, because of the size of available data and the need of real-time implementation of the model at the alloying stage, considered scenario generation techniques should also involve reduction of the set of scenarios. However, in comparison with various stochastic programming applications, the additional difficulty appears as in the studied models the relatively complete recourse is not guaranteed. Therefore, the problem-specific scenario generation techniques that take care about possible infeasibility of the first-stage decisions for removed scenarios have been developed and tested. Among tested ideas, we can list convex hulls applied to utilization matrices, principal component analysis for random losses of elements, and heuristic searches for the worst-case selection of scenarios. It is obvious that for different techniques, and hence, various resulting sets of scenarios, the optimal solutions may vary. Therefore, the results are compared by methodology that is mainly motivated by the application area. The non-reduced set of scenarios is used as a basis for such a comparison. Although the questions stated and answered are tightly related to the melt control application area, some of discussed ideas may also show their applicability within the wider framework.
(ThC, Catalina)

Powell, Warren. Princeton University
Missing Data, Noise and Lies: The Evolving Discovery of Misinformation in the Management of Boxcars in Rail Transportation
The allocation of box cars by railroads to customers can appear on the surface to be a textbook application of stochastic programming. There is a considerable amount of variability in customer requests, forcing railroads to use a variety of robust allocation strategies to allow them to provide a high level of service. In a project at a major railroad to implement a stochastic optimization model, we uncovered a rich array of information streams, introducing new sources of uncertainty as well as deliberate misinformation. In this talk, I will describe how this project unfolded, the evolution of stochastic programming models and algorithms that we used, estimated benefits, and issues that arose in the development and implementation of the system.
(TB, Grand Ballroom)

Pritchard, Geoffrey. University of Auckland, New Zealand
HERO (Hydro-electric reservoir optimization)
For the operator of a hydro-electric reservoir in a pool electricity market, the optimal stack to offer in each trading period over a planning horizon can be computed using dynamic programming. However, the market trading period (usually 1 hour or less) may be much shorter than the natural time scale of the reservoir (often many months). We devise a model to handle these two inherently different time scales. In this

model, the decision made at the beginning of each stage consists of a target mean and variance of the water release in the coming stage. This decomposes the problem into inter-stage and intra-stage subproblems. (MF, Catalina)

· Neame, Philip, University of Technology - Syd
· Philpott, Andrew, University of Auckland, New Zealand

Prékopa, Andras. RUTCOR, Rutgers University
Bounds on the values of financial derivatives under partial knowledge on the probability distribution
A large body of the literature on the calculation of the values of financial derivatives is based on the assumption that the time variations of the values of the underlying assets follow geometric Brownian motion processes. Black, Scholes and Merton gave a general method to compute the values of derivatives under the mentioned assumption. However, that assumption is invalid in many cases, there are significant differences between the hypothetical lognormal distributions and the data. In this paper we present general procedures to obtain lower and upper bounds for the values of derivatives (European put, call, basket, digital etc.) under univariate and multivariate moment information. We use the discrete moment methodology, developed by the author and others, for discretized asset prices, and combine it with cutting plane procedures, for the case of continuously distributed prices, to find the bounds. The bounding method can also be used in case of the Black-Scholes-Merton model, when the calculation of the moments is relatively easy but the calculation of the value is involved.
(ThD, South Ballroom)

Ramos, Andrés. Universidad Pontificia Comilla
Two-Stage Stochastic Models for Contracting Decisions of an Industrial Consumer
The price uncertainty and the new contracting possibilities that have arisen from the recent liberalization of energy markets show the necessity of new optimization tools for decision-making processes (Kirschen [2003], *IEEE Transactions on Power Systems*, Vol. 18 (2) pp. 520–527). Specifically, industrial consumers of electricity and heat who have their own energy supply system need to decide which energy contracts to sign and how to operate their energy supply system (Gomez and Ramos [2003], *IEEE Transactions on Power Systems*, Vol. 18 (2) pp. 716–723).

To formulate that problem, we propose a system composed of a steam boiler and a cogeneration plant fed by fuel oil and natural gas, respectively. With this configuration, the thermal demand is satisfied by the boiler or the cogeneration plant, whereas the electric demand is covered by the electric network or the cogeneration plant. Therefore, the following types of energy contracting decisions have to be made: the purchase of electricity, fuel oil and natural gas and the sale of surplus electricity produced by the cogeneration system. Different examples of representative contracts of each type of asset needing negotiation are modeled according to the alternatives and current situation of energy markets.

The problem consists of establishing energy contracts and supply system operation while keeping total annual energy costs at a minimum. This problem is formulated as a two-stage stochastic optimization model. The first stage decisions concern the different energy contracts while the second stage decisions represent the system (boiler and cogeneration plant) operation for each time period of the year. Binary variables appear in both stages, related to contract selection in the first stage and to boiler and cogeneration plant commitment in the second stage. Uncertainty in fuel oil, natural gas and electricity prices is considered in the second stage parameters. This uncertainty is represented by means of a scenario tree in which all of the scenarios come from a single root node with no additional branching.

Different risk approaches are analyzed independently. First, a risk-neutral model with the expected energy supply cost as the objective function is presented. Second, two bi-objective models are formulated. These models obtain a compromise, through a risk-aversion parameter, between the risk measure and the expected energy supply cost. The two risk measures considered are: 1) Value-at-Risk (VaR) (Lemming [2000, *Technical University of Denmark*, http://www.imm.dtu.dk/~jale/, Larsen et al [2002], *Financial Engineering, e-Commerce and Supply Chain*, Kluwer Academic Publishers, Gaivoronski and Pflug [2000] *Norwegian University of Science and Technology Management*, http://www.gloriamundi.org/picsresources/ggp1.pdf) and 2) safety-first or maximum cost (Roy [1952], *Econometrica*, Vol. 20 pp. 431–449). These risk measures are easy to interpret and penalize only high costs, which reflects the risk aversion of industrial consumers.

The resulting MIP stochastic problems are solved with standard algorithms. Different optimal contract portfolios for VaR and safety-first risk measures are calculated by varying the risk-aversion parameter. The efficient frontiers obtained for both risk measures are similar; however, the computation time is very different. The VaR approach requires much more time because of the implicit scenario selection involved in VaR evaluation.
(MC, Catalina)

· Gomez-Villalva, Emilio, Gomez-Villalva Ingenieros

Rekeda, Ludmyla. Stevens Institute of Technology
Statistical Tests for Stochastic Dominance
The comparison of distributions of uncertain prospects has been of considerable interest in various branches of science, finance, economics, insurance, and engineering. One of the most popular stochastic orders is based on the notion of stochastic dominance. Stochastic dominance plays an increasingly prominent role in the decision theory under uncertainty, and has multiple applications. We shall present the concept of stochastic dominance and indicate its implications. We will discuss and compare several approaches for testing stochastic dominance. New tests for stochastic dominance of second order will be presented.
(TD, Rincon)

· Dentcheva, Darinka, Stevens Institute of Technology

Rietbergen, Muriel. Centre for Financial Research, Judge Institute of Management, University of Cambridge
Designing Minimum Guaranteed Return Funds
In recent years there has been a significant growth of investment products aimed at attracting investors who are worried about the downside potential of the financial markets. This paper introduces a dynamic multistage stochastic optimization model for the design of such products. The pricing of minimum guarantees as well as the valuation of a portfolio of bonds based on a three-factor term structure model are described in detail. This allows us to accurately price individual bonds, rather than having to rely on a generalized bond index model.
(FB, South Ballroom)

· Medova, Elena, Centre for Financial Research, Judge Institute of Management, University of Cambridge

Rockafellar, Terry. University of Washington
Risk Measures and Safeguarding in Stochastic Optimization
Coping with the uncertainties in future outcomes is a fundamental theme in stochastic programming. It enters in the treatment of constraints as well as the treatment of objectives. Constraints that are dependent on the future have generally been relaxed by penalty expressions, unless they can be satisfied almost surely through recourse actions. Probabilistic constraints, requiring that a condition only to be satisfied up to a given probability, have been utilized sometimes instead, but with the drawback that convexity and even continuity in a problem formulation can be lost, except in special circumstances. Objectives have usually taken the form of maximizing expected utility or minimizing an expected cost which may come in part from constraint penalties. Some extensions involving information and entropy have also been explored. In financial optimization, where uncertainties are likewise unavoidable, approaches other than stochastic programming have prevailed. Although traditional portfolio theory focused on minimizing variance of return subject to a constraint on expected return, other approaches have more recently gained popularity. An important example is constraints and objectives based on the notion of value-at-risk, which relates closely to probabilistic constraints and unfortunately, therefore, suffers from

similar mathematical shortcomings. Value-at-risk suffers even from financial inconsistencies, which have led to the axiomatic development of "coherent risk measures", including the robust alternative called conditional value-at-risk. This talk will provide an overview of such current ideas and what they may have to offer for stochastic programming.
(ME, Grand Ballroom)

Rodríguez-Mancilla, José Ramón. Sauder School of Business, University of British Columbia and Banco de México
Living in the Edge: How risky is it to operate at the limit of the tolerated risk?
This paper studies the problem of maximizing the expected utility of the final wealth of an investor or decision maker subject to budget and risk tolerance constraints in a stochastic programming framework. Embedded probability measures are uncovered through the concept of duality and used to assess the probability of surpassing the Value at Risk threshold. Moreover, one of these embedded probabilities is used to define a new monetary risk measure that determines a capital requirement that is better than Value at Risk but less demanding than Conditional Value at Risk.
(MD, Rincon)

Roemisch, Werner. Humboldt-University Berlin
Scenario modelling for multistage stochastic programs
Most approaches for solving multistage stochastic programs are based on an approximation of the underlying probability distribution by a discrete measure whose scenarios exhibit tree structure. We review some recent approaches for generating scenario trees and discuss the best approximation approach in more detail. In the latter an approximate scenario tree is determined with respect to a suitable distance of probability distributions relying on stability arguments for multistage models. In particular, we present and study an algorithm for constructing scenario trees starting from a fan of individual scenarios. Numerical experience is reported for a number of instances, e.g., for the generation of passenger demand scenario trees in airline revenue management and of load-price trees in electricity portfolio management.
(ThB, Grand Ballroom)

· Heitsch, Holger, Humboldt-University Berlin

Ruszczynski, Andrzej. Rutgers University
Risk-averse stochastic optimization: stochastic dominance constraints
We introduce a new stochastic optimization model with stochastic dominance constraints. It is a new decision model under uncertainty involving comparison of random outcomes dependent on the decisions to stochastic reference points. We develop necessary and sufficient conditions of optimality and duality theory for these models. Furthermore, we show that the Lagrange multipliers corresponding to dominance constraints are concave non-decreasing utility functions. The analysis demonstrates that the expected utility approach is dual to the new one. Next, we develop a theory of splitting for these models, and specialized decomposition methods. The results are illustrated on a portfolio optimization problem.
(TD, Rincon)

· Dentcheva, Darinka, Stevens Institute of Technology

Rømo, Frode. SINTEF Industrial Management
Supply Chain Management in the Natural Gas Business – A SP based application for tactical and operational trading in liberalized markets
SINTEF (The Foundation for Scientific and Industrial research at the Norwegian Institute of Technology) has over the last couple of years developed a model and implemented an application for tactical planning in natural gas trading for Statoil. Statoil is the major Oil- & Gas- company in Norway, and provides about 10 percent of the natural gas to the European gas markets.

The aim of the project has been to develop methodology and decision support models that incorporate an overall view of the production, transportation and market behavior for the supply of natural gas from the

Norwegian continental shelf. A major challenge is to establish decision-making processes that facilitate a dynamic coordination of the activities aimed at the market place.

The gas directive from the European commission and the initiatives to liberalize the European energy markets has lead to a new situation for the gas producers with a particular focus on increased short-term variation in supply and demand.

The application represents both the physical limitations in connection with gas transmission, and the economic value chain regarding market conditions and trading possibilities.

The model describes the total planning problem of a natural gas producer including production, transmission and trading. Take or pay contracts are modeled as long term delivery obligations, having uncertain volumes and prices. In addition we include stochastic spot-markets and forward-markets giving the actors increased trading flexibility.

The objective is to maximize profit based on existing infrastructure rights and production facilities in a tactical time horizon, which is for a period of 18 to 36 months.

The model is implemented as a mixed integer multistage stochastic programming model. Scenario trees are generated by a combination of forecasting and moment matching based on empirical time series.
(TC, Rincon)

· Fodstad, Marte, SINTEF Industrial Management
· Nowak, Matthias, SINTEF Industrial Management
· Tomasgard, Asgeir, Norwegian University of Science and Technology

Sahinidis, Nikolaos. University of Illinois at Urbana-Champaign
Stochastic integer programming: algorithms and applications
A large number of problems in production planning and scheduling, location, transportation, finance, and other areas require that discrete decisions be made in the presence of uncertainty. Uncertainty, for instance, governs the prices of fuels, the availability of electricity, and the demand for chemicals. Discrete decisions, on the other hand, are needed in order to model technology selection from a set of mutually exclusive alternatives, sequencing of production tasks, discrete production lots, etc. The presence of integer variables considerably complicates a stochastic program. Because of the nonconvex nature of the value function of an integer program, stochastic integer programming becomes particularly difficult when integer variables appear in the second or subsequent stages. This talk will provide a review of algorithms and applications for stochastic integer programming. We discuss heuristics, approximation schemes, and exact algorithms, including decomposition, Lagrangian relaxation, algebraic enumeration, sampling, and convexification approaches.
(TE, Grand Ballroom)

Schaefer, Andrew. University of Pittsburgh
Integral Stochastic Programs
We consider a class of *integral stochastic programs*, that is, stochastic integer programs that can be solved as stochastic linear programs due to the total unimodularity of their extensive form constraint matrices. We give several sufficient conditions for integral SPs, and provide necessary and sufficient conditions for specific classes of problems. When solving such problems using the L-shaped method it is not clear whether the integrality restrictions should be imposed on the master. Such restrictions will make the master more difficult to solve. On the other hand, solving the linear relaxation of the master may mean sending fractional (and clearly nonoptimal) solutions to the subproblems. Our computational results investigate this trade-off and provide insight into which strategy is preferable under a variety of circumstances.
(WA, Rincon)

· Ahmed, Shabbir, Georgia Institute of Technology
· Kong, Nan, University of Pittsburgh

Schuerle, Michael. University of St. Gallen
Multistage Stochastic Programming Models in Asset & Liability Management
Increasing pressure from the market and regulatory requirements have forced banks to take the leap from a static view of the balance sheet towards a dynamic analysis of their positions. Multistage stochastic programming models are well suited in this context as decision support systems for the implementation of dynamic investment and hedging strategies. Special emphasis must be placed on modeling the evolution of risk factors, generation of scenarios and valuation of the relevant financial instruments. We address these issues with focus on applications to asset & liability management problems and present examples of models for the dynamic replication of core deposits and hedging of a bank's entire balance.
(FA, South Ballroom)

· Grollmann, Manfred, University of St. Gallen
· Haeusler, Frank, University of St. Gallen

Schultz, Rüdiger. Institute of Mathematics, University Duisburg-Essen
On Deviation Measures in Stochastic Integer Programming
We propose extensions of traditional expectation-based stochastic integer programs to mean-risk models. Risk is measured by expected deviations of suitable random variables from their means or from preselected targets. We derive structural properties of the resulting stochastic programs and present first algorithmic ideas to achieve problem decomposition.
(MF, South Ballroom)

· Märkert, Andreas, Institute of Mathematics, Univ

Schütz, Peter. Norwegian University of Science and Technology
Facility location under economics of scale in the case of uncertain demand
This paper adresses facility location under uncertain demand. The problem is to determine the optimal location of facilities and allocation of customer demand to these facilities. The costs of operating the facilities are subject to economics of scale and customer demand is uncertain. The objective is then to minimize the total expected cost. These costs can be split into three parts: firstly the costs of investing in a facility and maintaining it, secondly the costs of operating a facility with strictly diminishing average costs, and thirdly linear transportation costs. We show a solution method for this problem based on Lagrangean Relaxation. We present computational results from the Norwegian meat industry and the location of slaughterhouses.
(TF, Rincon)

· Stougie, Leen, Eindhoven University of Technology
· Tomasgard, Asgeir, Department of Industrial Economics, Norwegian University of Science and Technology

Sen, Suvrajeet. SIE Department, University of Arizona
Decision Aids for Scheduling and Hedging (DASH): Computational Implications of Multi-scale Modeling
The DASH model is an large-scale MILP which combines both financial considerations of electricity portfolios, as well as generation considerations associated with physical assets. The resulting problem is a multi-scale stochastic optimization model which includes both strategic and tactical decisions. We will discuss our computational experiments which examine a variety of issues. In particular, we study whether the inclusion of integer variables, and hedging constraints are necessary. We will also argue the need for simulation experiments that emulate the sequential process associated with making observations, and then using these observations to update the stochastic programming model.
(MC, Catalina)

· Talat, Genc, University of Guelph, Canada

· Yu, Lihua, Purdue University

Shanbhag, Uday V.. Department of Management Science and Engineering, Stanford University
An Interior Sampling Algorithm for the Solution of Stochastic Nash Games
We consider a class of equilibrium problems in which agents solve stochastic convex quadratic programs(QPs). By using a novel reformulation, we may solve this class of problems by an interior sampling algorithm. The second part of the paper considers the problem of electricity pricing in imperfect markets under uncertainty. By extending the ideas of Hobbs et al., we discuss the efficient solution of large stochastic Nash Cournot problems.
(TA, Catalina)

· Glynn, Peter, Department of Management Science and Engineering, Stanford University
· Infanger, Gerd, Department of Management Science and Engineering, Stanford University

Shastri, Yogendra. University of Illinois, Chicago
Application of stochastic programming for optimal sensor placement in water distribution networks
Stochastic nonlinear programming problems are solved using sampling to represent model uncertainties. Algorithms are developed to propagate these model uncertainties into optimization and decision making. But large number of samples needed for effective uncertainty representation results in a computationally demanding solution method. To circumvent this problem, a stochastic nonlinear programming algorithm, Better Optimization of Nonlinear Uncertain Systems (BONUS), has been proposed which uses sampling along with reweighting scheme. This work deals with the application of this algorithm to sensor placement problem in water distribution network.

Contamination of water and the subsequent risk to the population can be minimized by placing sensors in the water network at design stage. Due to economic considerations, maximum benefits from minimum number of sensors need to be achieved. The problem tackled in this work relates to the optimal sensor location identification in a given network to minimize contamination begotten risk. Uncertainty in population density and demands is incorporated to make the analysis closer to real life applications. Starting with the problem formulation from an earlier work, the work extends the formulation to a more extensive form, incorporating uncertainty at a broader level. Uncertainty consideration makes this a Stochastic Nonlinear Programming (SNLP) problem which is converted to a two stage stochastic programming problem with recourse and solved using the BONUS algorithmic framework. The decomposition strategy of L-shaped method is used for the same. Hammersley sequence sampling (HSS), because of its k dimensional uniformity property, is used to model various uncertainties. EPANET simulator has been used for water network simulations.

The proposed solution method is tried on an example network from EPANET simulator. Three possible solution strategies have been investigated, starting from the purely deterministic one to the one with extensive uncertainty consideration. The results for the network show that the consideration of uncertainty affects the objective function values (risk) as well as the placement of sensors in the network. The results therefore indicate that the new formulation gives a more exhaustive picture of the actual situation and hence is a valuable tool for further analysis.
(TF, Rincon)

· Diwekar, Urmila, University of Illinois, Chicago

Siegrist, Simon. Institute for Operations Research, University of Z urich
Aggregation and recursion in MSLP's with infinite support
Aggregation of constraints and decisions in multistage stochastic linear programs (MSLP) seems to be a natural way to make them numerically manageable. In the two-stage case several methods are based on the assumption that an optimal solution of the dual aggregated problem is at least feasible in the original one, which leads to lower bounds. We discuss an extension of this property for the multistage case. Based on

such dual solutions, we get a recursively defined policy in the original primal problem by solving small quadratic programs. Relatively complete recourse (RCR) ensures not only that the primal policy is well-defined but also that dual solutions are bounded, provided that the RCR property is inherited by the aggregated problems. In the multistage case, inheritance requires an additional assumption. Furthermore, scenario simulation yields a measure of goodness for the current aggregation as well as some information for local refinement.
(ThA, Catalina)

Silva, Eduardo. Naval Postgraduate School
Solving a Stochastic Facility-Location Problem by Branch and Price
We formulate a stochastic facility-location problem (SFLP) using a scenario-representation of uncertainty; demands, facility capacities and costs may all be uncertain. The column-oriented formulation improves the model by moving randomness into the subproblems, without requiring independence among random parameters. We solve this model with a branch-and-price algorithm (B&P) implemented with the BCP/COIN-OR library, and with CPLEX; and we demonstrate how convergence can be accelerated with duals stabilization, strong branching and other techniques. Computational results show that B&P can be orders of magnitude faster than solving the original problem by branch and bound, and this can be true even for single-scenario problems, i.e., for deterministic problems. We also show how to solve SFLP exactly with B&P under certain distributional assumptions for uncertain parameters, e.g., normally distributed demands and capacities, random unmet-demand penalties having finite mean, and independence among all random variables.
(TD, South Ballroom)

· Wood, Kevin, Naval Postgraduate School

Singh, Kavinesh. University of Auckland
Column Generation for Solving a Stochastic Capacity-Expansion Model for Electric Power Distribution
We develop a stochastic capacity-expansion model for a New Zealand electric-power distribution company. New power lines or other equipment must be installed to cope with growing and uncertain demand over a multi-year planning horizon. The model minimizes the expected, discounted cost of an investment schedule. We formulate the problem as a multi-stage stochastic mixed-integer program with a scenario-tree representation of uncertain demand.? At each node of the scenario-tree, the model involves: (a) capacity-expansion decisions; (b) configuration decisions that determine which links in the "mesh network" to switch in or out so the network operates as a tree; and (c) power flows to meet demands. We reformulate a "basic model" using a "super-arc representation" of the network that significantly reduces the number of binary variables and provides a tighter linear-programming relaxation. Dantzig-Wolfe decomposition leads to (a) a master problem containing binary capacity-expansion and high-level operating decisions; and (b) column-generating subproblems which are mixed-integer programs representing single-period, deterministic capacity-expansion models. This (branch-and-price) solution approach makes the model a viable analytic tool as we can now solve large, realistic problems. We also show how the model can be adapted to handle (a) switch-installation decisions; (b) reliability constraints; and (c) demand-side controls (e.g., can we save money by paying a large industrial customer to convert to an alternative power source?).
(TD, South Ballroom)

· Philpott, Andrew, University of Auckland
· Wood, Kevin, Naval Postgraduate School

Sinha, Amitabh. University of Michigan
Stochastic Network Design
We study the problem of constructing single-source networks in a two-stage stochastic optimization model with finite scenarios and recourse. We use linear programming and combinatorial optimization tools to provide a robust constant-factor approximation algorithm.
(MC, Rincon)

· Gupta, Anupam, Carnegie Mellon University
· Ravi, R., Carnegie Mellon University

Smith, Cole. University of Arizona
An Algorithm for the Minimum Risk Problem with Binary First-Stage Variables
In this talk, we prescribe a Benders' Decomposition-based algorithm for solving the minimum risk problem, in which first-stage decisions are made, followed by the realization of one of several (finite) scenarios, after which a set of second-stage decisions is made. For our problem, the first-stage decision variables are restricted to be binary, and the second-stage variables are continuous, with the exception of a single binary variable. The second-stage continuous variables can represent recourse actions, or perhaps simply an accounting of the costs that result in some scenario due to the first-stage decisions, while the second-stage binary variable equals one if and only if some risk (e.g., due to exceeding a budgetary or security threshold) is incurred. The second-stage costs are due solely to whether or not this risk threshold is exceeded.

We first demonstrate that such problems can be reformulated by convexifying the feasible region of the second-stage subproblem via the Reformulation-Linearization Technique (RLT) of Sherali and Adams (1990, 1994), which permits us to solve the subproblems as linear programs, and thus permits the use of classical Benders' decomposition to solve the problem. A disadvantage of this technique is that RLT substantially increases the size of the subproblems, which can introduce computational difficulties if many subproblems exist. To combat this problem, we show that the Benders' constraints that would be derived from the enlarged RLT-based subproblem formulation can be obtained by simply solving the linear relaxation of the original subproblem formulation, followed by a simple scaling and adjustment procedure.

Finally, we consider the case in which risk is applied at various levels. In this case, the second-stage decisions consist of some continuous variables, and a single array of binary risk variables. Each of these variables corresponds to a different level of risk for its scenario, and equals to one if and only if that exact level of risk is incurred. Since the sum of these binary variables cannot exceed one, we can exploit this Generalized Upper Bound constraint by the Special Structures RLT (SSRLT) of Sherali, Adams, and Driscoll (1998) to convexify the second-stage subproblem feasible regions. For this problem, we provide a method for deriving the Benders' cut that would be obtained from solving the full SSRLT-based problem by first solving a much smaller linear program and then determining the appropriate level of risk that is incurred due to the first-stage decisions in that stage.

We conclude this talk by presenting some preliminary computational results and discussing avenues for future research in this area.
(TA, South Ballroom)

· Sherali, Hanif, Virginia Tech

Stougie, Leen. Technische Universiteit Eindhoven and CWI, Amsterdam
Worst-case performance analysis of polynomial time algorithms for a stochastic service provision problem
The service-provision problem is the problem to maximize a service provider's profit from offering computational based services to customers. The service provider has limited capacity and must choose which of a set of software applications he would like to offer. The problem is examined in the framework of stochastic integer programming, when demand is described by scenarios, each with a corresponding probability of occurrence.

Since the deterministic problem is NP-hard, the two-stage stochastic version with scenario specified probability distributions is also NP-hard (see Dyer and Stougie 2003). If the stochasticity is described by independent random variables, two stage stochastic programming problems are in general $\sharp$-P hard (see Dyer and Stougie 2003).

However, for the deterministic single node service provision problem a fully polynomial approximation scheme is known (see Dye, Stougie, and Tomasgard 1998). We show that introduction of stochasticity within the scenario model makes the problem strongly NP-hard, implying that the existence of such a scheme for the stochastic problem is highly unlikely.

For the general case a heuristic with a worst-case performance ratio that increases in the number of scenarios is presented. Restricting the class of problem instances in a way that many reasonable practical problem instances satisfy, allows for the derivation of a heuristic with a constant worst-case performance ratio. Worst-case performance analysis of approximation algorithms is classical in the field of combinatorial optimization, but to the best knowledge of the authors this is one of the first result in this direction in stochastic programming.

After our paper several papers with this scope have been published. The work of Dyer, Kannan, and Stougie (2002) gives a randomized quasi-polynomial approximation scheme for a general class of two-stage stochastic programming problems. Other papers by Gupta et al. (2004),Ravi and Sinha (2004), and Shmoys and Swamy (2004) will be presented on this meeting.
(MC, Rincon)

Strugarek, Cyrille. EDF R&D and Ecole Nationale des Ponts et Chaussées
A theorem on dual effect free stochastic scalar state space systems
All multi-stage stochastic programs can be seen as controlled stochastic input-output systems. The outputs of the system (the observations) depend on past controls (equivalently inputs), and induce in their turn measurability constraints on controls (which have to be measurable with respect to "observations").
Controls can therefore have a double action: they may influence both the cost function of the system and the measurability constraints of the problem.
This double influence of controls is known in literature as the *dual effect* (see [a]) and possibly renders stochastic programs numerically untractable. Typically, a tree construction has no sense in this case, since controls deeply change future information.
It is therefore important to know whether a control will be dual effect free or not.
Following SOWG (Systems Optimization Working Group, CERMICS, Ecole Nationale des Ponts et Chaussées, Marne-la-Vallée, France), it is clear that the difficulty arises in describing the set of all control variables which do not cause any dual effect, i.e., for which the measurability constraints associated with the observations are constant.
SOWG recently showed (see [b]) that the set of *no dual effect* controls can be properly described, under the assumptions that open-loop controls (constant controls) are dual effect free, and that one has *perfect memory* of past observations and observation causality. The assumption of *no open-loop dual effect* is related to the structure of our stochastic sytem. Systems for which open-loop controls are dual effect free will be called NOLDE (*no open-loop dual effect systems*).
An important question is to find a characterization of the NOLDE systems. After recalling technical definitions and properties on dual effect and stochastic systems, we will first prove two results, namely that absence or presence of a dual effect is invariant under a coordinates change, and that all linear stochastic systems with perfect memory are NOLDE.
In usual words of multi-stage stochastic programming, it means that any multi-stage stochastic program with perfect memory, in which both observation and dynamic are stationary linear functions (of states, controls and noises, which are all assumed to be real valued), is NOLDE, and consequently, we can define for such systems the set of dual effect free closed-loop controls, and try to solve the problem with controls in this feasible set.
The main result of our work is that, under local invertibility assumptions, any NOLDE stochastic system which is one-dimensional (observations, controls and noises are real valued) and is homogeneous (equivalently stationary, i.e., time independent) can be made linear through a coordinates change, i.e., the observation function can be made linear in noise and state, whereas dynamic function can be made linear in control, but remains non-linear in state and noise.
Further works are actually in progress to show that one can make dynamics also linear in state and noise if one has more than two time steps in the stochastic system.

[a] H.S. Witsenhausen, A counterexample in stochastic optimal control. *SIAM Journal of Control*, 2(6):149-160, 1968.

[b] K. Barty, P. Carpentier, J.-P. Chancelier, G. Cohen, M. de Lara and T. Guilbaud. Dual Effect free stochastic controls. *Annals of Operations Research*, 2004.
(TA, Rincon)

· de Lara, Michel, CERMICS, Ecole Nationale des Ponts et Chaussées

Swamy, Chaitanya. Cornell University
An Approximation Scheme for Stochastic Linear Programming and its Application to Stochastic Integer Programs
Stochastic optimization problems attempt to model uncertainty in the data by assuming that the input is specified by a probability distribution. We consider the well-studied paradigm of 2-stage models with recourse: first, given only distributional information about (some of) the data one commits on initial actions, and then once the actual data is realized (according to the distribution), further (recourse) actions can be taken. We show that for a broad class of 2-stage linear models with recourse, one can, for any $\epsilon > 0$, in time polynomial in $\frac{1}{\epsilon}$ and the size of the input, compute a solution of value within a factor $(1+\epsilon)$ of the optimum, in spite of the fact that exponentially many second-stage scenarios may occur. This result is based on reformulating the stochastic linear program, which in general has both an exponential number of variables and an exponential number of constraints, as a compact convex program, and adapting methods from convex optimization to give a randomized polynomial algorithm that returns a near-optimal solution to the stochastic LP. In doing so, a significant difficulty that we must overcome is that even evaluating the objective function of this convex program may be quite difficult and provably hard. Our algorithm does not require any assumptions about the probability distribution (or the cost structure of the input); all we require is a "black box" that one can use to draw independent samples from the distribution. Second, we give a rounding approach for stochastic integer programs that shows that approximation algorithms for a deterministic analogue yields, with a small constant-factor loss, provably near-optimal solutions for the stochastic generalization. We obtain the first approximation algorithms for a variety of 2-stage stochastic integer optimization problems where the underlying random data is given by a "black box" and no restrictions are placed on the costs of the two stages. Among the applications we consider are stochastic versions of the multicommodity flow, set covering, and facility location problems.
(MC, Rincon)

· Shmoys, David, Cornell University

Szántai, Tamás. Budapest University of Technology
On Numerical Calculation of Probabilities According to Dirichlet Distribution
The main numerical difficulty in probabilistic constrained stochastic programming problems is the calculation of the probability values according to the underlying multivariate probability distributions. From point of view of the nonlinear programming algorithms to be applied it is preferable to be able to calculate the first and second order partial derivatives of these probability functions according to the decision variables. In the lecture we will give a solution to the above problems in the case of Dirichlet distribution. For the calculation of the cummulative distribution function values the Lauricella function series expansions will be applied up to 7 dimensions. For higher dimensions we propose the hyper-mutitree bound calculations and a variance reduction simulation procedure based on these bounds. There will be given formulae for the calculation of the first and second order partial derivatives, too. The common property of these formulae is that they involve only lower dimensional cummulative distribution function calculations. At the end of the lecture some multivariate distributions will be mentioned which are derived form the Dirichlet distribution and may have very interesting applications in jointly constrained stochastic programming models.
(WC, Rincon)

· Gouda, Ashraf, Budapest University of Technology

Thénié, Julien. Logilab - University of Geneva
Stochastic programming with linear decision rules
In this research, we plan to revisit stochastic programming and couple it with the technique of linear decision rules. Multi-periodic problems with recourse are thus transformed into two-stage models with a minimal loss of generality. The new approach will make it possible to analyse and solve problems that up to now are deemed to be out of scope for standard stochastic programming.

We show on an example in supply chain management, that a model based on linear decision rules yields solution that are comparable with the exact approach of stochastic programming, but at a much smaller computational cost.
(FB, Rincon)

· Vial, Jean-Philippe, Logilab - University of Geneva

Tiedemann, Stephan. Institute of Mathematics, University Duisburg-Essen
On Some Risk Measures in Stochastic Integer Programming
We consider the following risk measures and the corresponding mean-risk models in the framework of two-stage stochastic mixed-integer programming: Excess Probability, Value-at-Risk, Expected Excess and Conditional Value-at-Risk. The talk addresses structure, stability and algorithms for these models.
(MF, South Ballroom)

· Schultz, Rüdiger, Institute of Mathematics, University Duisburg-Essen

Tipi, Horia. Dash Optimization Inc.
Building stochastic applications in Xpress-SP
Optimization under uncertainty is a challenging task. Real-world applications require a framework for rapid experimentation, prototyping and analysis in order to gauge the impact of uncertainty on the decision-making process. The purpose of this talk is to introduce Xpress-SP – an optimization tool for 2-stage and multi-stage mixed integer stochastic linear programs, and demonstrate its modeling, solving and visualization capabilities using examples from energy sector and inventory optimization.
(WA, Catalina)

· Verma, Nitin, Dash Optimization

Tomasgard, Asgeir. NTNU
Combining scenario generation and forecasting
This paper presents two approaches for combining forecasting methods with scenario generation. The motivation is that most companies are traditional in respect of the tools they are using for analysis and we would like to see how traditional forecasting techniques can be combined with ideas from stochastic programming. In this way we get a representation of the uncertainty through a scenario tree, still keeping the forecasting method the user is familiar with. In the first approach based on quantile regression, the forecasting method and its parameter estimation is completely integrated in the scenario generation. This makes it possible to change the parameters of the forecasting method along the path from the root node to a leaf node in the scenario tree. This method only works for single stochastic variables or uncorrelated variables. In the second approach we separate completely the choice of forecasting method and its parameter estimation from the generation of scenarios. Typically in real life applications many of the stochastic variables are highly correlated. We generate multi-dimensional scenario trees based on the following steps:

- Forecasting the uncertainty for these multidimensional variables
- Principal component analysis and dimension reduction to identify uncertain factors
- Generating samples for uncertainty factors

- Combining the forecasts and the samples in order to build a scenario tree.

. Examples from natural gas prices and supply chain management will be presented.
(ThF, Rincon)

· Nowak, Matthias, SINTEF

Topaloglu, Huseyin. Cornell University
Separable approximation strategies for discrete resource allocation under uncertainty
We consider the stochastic programming problem

$$\max_{x \in \mathcal{X}} \mathbb{E} f(x, \omega),$$

where $f(\cdot, \omega) : \mathbb{R}^n \to \mathbb{R}$, $\mathcal{X}$ is convex, and $f(x_1, \dots, x_{i-1}, \cdot, x_{i+1}, \dots, x_n, \omega)$ is piecewise-linear and concave with points of nondifferentiability being a subset of integers. We propose to solve these problems by using separable, piecewise-linear, concave approximations of the objective function, which are obtained through an iterative scheme. Letting

$$F^k(x) = \sum_{i=1}^{n} f_i^k(x_i)$$

be the approximation at iteration k, our iterative approach solves the problem

$$x^k = \arg\max_{x \in \mathcal{X}} \sum_{i=1}^{n} f_i^k(x_i),$$

samples an outcome of ω, say ω^k, and uses the slope information

$$v_i^k = f(x_1^k, \dots, x_{i-1}^k, x_i^k \mp 1, x_{i+1}^k, \dots, x_n^k, \omega^k) - f(x_1^k, \dots, x_{i-1}^k, x_i^k, x_{i+1}^k, \dots, x_n^k, \omega^k)$$

to obtain a new approximation $f_i^{k+1}(\cdot)$, which, in turn, makes up the approximation $F^{k+1}(\cdot) = \sum_{i=1}^{n} f_i^{k+1}(\cdot)$ at the next iteration. When the objective function of the original problem is itself separable, it can be shown that the sequence $\{x^k\}$ generated by such an iterative scheme converges to an optimal solution. While this problem class enjoys its own set of applications (for example, budget allocation problems), our interest is in solving general two-stage stochastic programs, whose recourse functions are not necessarily separable. Unfortunately, the convergence characteristics of our separable approximation scheme is lost when applied to the latter problem class. However, one can still heuristically apply it by using the dual solution of the second stage problem instead of the slope information $\{v_i^k : i = 1, \dots, n\}$. Our numerical experiments show that such a heuristic implementation yields high-quality solutions very fast. Furthermore, one can quickly estimate the "optimality gap" at each iteration by solving a problem of the form

$$\min_{x \in \mathcal{X}} F'^k(x^k, x^k - x),$$

where $F'^k(x^k, d)$ is the directional derivative of $F^k(\cdot)$ in direction d.
(FB, Rincon)

· Powell, Warren, Princeton University
· Ruszczynski, Andrzej, Rutgers University

Uppal, Raman. London Business School
Portfolio Investment with the Exact Tax Basis via Nonlinear Programming
Computing the optimal portfolio policy of an investor facing capital gains tax is a challenging problem: because the tax to be paid depends on the price at which the security was purchased (the tax basis), the optimal policy is path dependent and the size of the problem grows exponentially with the number of time periods. A popular approach to address this problem it to approximate the exact tax basis by the weighted average purchase price. Our contribution is threefold. First, we show that the structure of the problem has several attractive features that can be exploited to determine the optimal portfolio policy using the exact tax basis via nonlinear programming. Second, we characterize the optimal portfolio policy in the presence of capital-gains tax when using the exact tax basis. Third, we show that the certainty equivalent loss from using the average tax basis instead of the exact basis is very small: it is typically less than 1

· DeMiguel, Victor, London Business School

Uryasev, Stan. University of Florida
Drawdown Measure in Portfolio Optimization
A new one-parameter family of risk measures called Conditional Drawdown (CDD) has been proposed. These measures of risk are functionals of the portfolio drawdown (underwater) curve considered in active portfolio management. For some value of the tolerance parameter alpha, in the case of a single sample path, drawdown functional is defined as the mean of the worst (1-alpha)*100

· Chekhlov, Alexei, –
· Zabarankin, Michael, University of Florida

van der Vlerk, Maarten H.. University of Groningen
Convex approximations for mixed-integer recourse models
We consider mixed-integer recourse (MIR) models with a single recourse constraint. We relate the second-stage value function of such problems to the expected simple integer recourse (SIR) shortage function. This allows to construct convex approximations for MIR problems by the same approach used for SIR models.
(TF, South Ballroom)

Van Hentenryck, Pascal. Brown University
Online Stochastic Combinatorial Optimization under Time Constraints
This talk considers online stochastic optimization problems where time constraints severely limit the number of offline optimizations which can be performed at decision time and/or in between decisions. It proposes a novel approach which combines the salient features of the earlier approaches: the evaluation of every decision on all samples (expectation) and the ability to avoid distributing the samples among decisions (consensus). The key idea underlying the novel algorithm is to approximate the regret of a decision d. The regret algorithm is evaluated on two fundamentally different applications: online packet scheduling in networks and online multiple vehicle routing with time windows. On both applications, it produces significant benefits over prior approaches.
(MD, South Ballroom)

Vardar, Cem. Arizona State University
Stochastic optimization using several layers of models with different levels of abstraction
In this study we present a atochastic optimization approach that uses models with different levels of abstraction throughout a metaheuristic search process. In this approach we use less detailed models to quickly browse the solution space at the beginning of the search process where we have little information about the form of the good solutions and gradually increase the level of detail as we improve the solution. We compare our approach with existing methods using a location/capacity optimization problem from the semiconductor manufacturing industry.
(TD, Catalina)

· Fowler, John, Arizona State University
· Gel, Esma, Arizona State University

Vehviläinen, Iivo. Fortum Power and Heat Oy, Finl
Arbitrage pricing of financial contracts in incomplete markets
This paper characterizes the set of arbitrage-free prices of a general class of financial contracts in incomplete markets. The considered class covers, for example, American contingent claims, mortage loans, and swing options which are delivery contracts traded in energy markets. The set of arbitrage-free prices is an interval where the lower bound is obtained by maximizing the expected cash-flows over exercise strategies and minimizing over martingale measures. The upper bound is obtained by changing the minimization into maximization. In case of ACCs, this reduces to known characterizations of the arbitrage-free interval in terms of stopping times. Our approach is based on convex stochastic optimization which suggests efficient computational techniques for calculation of the prices.
(ThF, Catalina)

· Pennanen, Teemu, Helsinki School of Economics

Vladimirou, Hercules. University of Cyprus
A Stochastic Programming Framework for Managing International Portfolios of Financial Assets
We develop and implement a stochastic programming framework for managing portfolios of stock and bond indices denominated in multiple currencies. Internationally diversified portfolios broaden the scope for diversification, but are exposed to market risks and currency risks. The international portfolio selection problem and the risk hedging decisions are typically considered separately in the literature and in practice. We take a holistic view of the problem and employ multistage stochastic programming models that address the risk management issues in an integrated manner. The models determine not only the asset allocation in each market but also the selection of specific securities within each market, as well as the use of appropriate instruments for hedging the two main sources of risk. We explore alternative risk hedging strategies. We consider options on stock indices as means for controlling the market risks. Both simple options as well as quantos (integrative instruments that cover both market and currency risk) on international stock indices are considered. For the case of the currency risk, we consider either forward currency contracts or currency options as means to control the currency risk. Thus, several interrelated decisions are addressed in a common framework. The incorporation of options in stochastic optimization models for portfolio management is a novel contribution. Uncertainty in the asset returns and exchange rates is represented by means of discrete distributions (scenario sets). Empirical evidence indicates that these random variables exhibit asymmetric distributions and fat tails. Hence, we employ a moment-matching scenario generation procedure that captures asymmetries and excess kurtosis in the distributions of the random variables, as well as their correlations. For internal consistency of the optimization models the options must be priced consistently with the postulated scenario sets for the underlying securities, while at the same time satisfying fundamental economic principles (i.e., no-arbitrage conditions). To this end, we adapt appropriate procedures for pricing the options consistently with the scenario sets for the underlyings. Through extensive computational experiments, both in static as well as in dynamic settings we demonstrate: (a) the benefits of international diversification, (b) the impact of alternative hedging strategies – including options – to control the main risk exposures, (c) the relative performance of alternative risk hedging strategies. We find that additional benefits are gained as an increasingly integrated view towards total risk management is taken, i.e., as the constituent risks are jointly controlled through appropriate means.
(FB, Catalina)

· Topaloglou, Nikolas, University of Cyprus
· Zenios, Stavros, University of Cyprus

Wallace, Stein. Molde University College, Norway
Evaluation of scenario-generation methods for stochastic programming
We discuss the evaluation of quality/suitability of scenario-generation methods for a given stochastic programming model. We formulate minimal requirements that should be imposed on a scenario-generation method before it can be used for solving the stochastic programming model. We also show how the requirements can be tested. The procedure of testing a scenario-generation method is illustrated on two cases: one from portfolio management, using a moment-based scenario-generation method; the other from logistic, using a method combining distribution functions and correlations.
(ThF, Rincon)

· Kaut, Michal, The University of Edinburgh, S

Wang, Wei. ISyE, Georgia Tech
Algorithms for mean-risk stochastic programs
Recently, a great deal of theoretical progress has been made for explicitly addressing risk in stochastic programs. In this talk we discuss algorithmic issues pertaining to this theory. In particular, we shall describe decomposition schemes for solving certain mean-risk stochastic programs, and present illustrative computational results.
(MD, Rincon)

· Ahmed, Shabbir, Georgia Institute of Technology

Wets, Roger J-B. University of California, Davis
Making Stochastic Programming User-Friendly
Almost all important decision making problems are, in reality, decision making problems under uncertainty. Ignoring uncertainty often carries a very high price: the solutions generated by an over-simplified 'deterministic' version of the problem often aren't robust and, sometimes, are seriously misleading. This idea, that important decision needs to 'hedge' against an uncertain future, highlights an inherent feature of such problems: the complicating role of system dynamics. In other words, some decisions are made prior to observing the uncertain components of the problem and, usually, another round of recourse decisions will make adjustments after the values of these uncertain parameters have been completely, or partially, realized. The most important and challenging class of such decision models are those where the uncertainty is only revealed over time with the possibility that some corrective actions (i.e., recourse decisions) can be made more or less at any time during the evolution of the system; dynamics might be time-dependent but could also be distributed over space. The challenge is to provide reliable solution procedures and the support-systems that allow for relatively easy formulation and analysis of the solution. In this lecture, I shall explore the mathematical, modeling, computational and related computer science issues that must be explored/met to render the use of stochastic programming models available to a larger community of potential users.
(MB, Grand Ballroom)

Wirojanagud, Pornsarun. Arizona State University
Workforce Planning Under Uncertainty
Effective management of workforce resources is typically an essential aspect when dealing with labor intensive or high labor cost industries. Cross-training in the workforce is an effective option as it provides agility and acts as a buffer against variability in the system. However, cross-training is generally costly and organizations need to be careful and prudent with their decisions. Effective workforce management should provide answers to questions concerning the size of the technical pool, the balance between specialists and cross-trained generalists, and the efficient allocation of labor resources to tasks. Prior work on workforce planning and management has addressed various issues such as where and why cross-training is an attractive option. However, they generally assumed that workers are identical. Human Resource Management (HRM) literature shows that individuals are different from each other. There are influence of abilities and personal characteristics on job performance and other workplace relevant criteria. From the

HRM literature, general cognitive ability (g) appears to be important for job performance across all jobs. The degree of "g" possessed by workers has been found to be strongly related to job performance regardless of the type of job. In a manufacturing environment, the demand for operators is difficult to forecast. In order to deal with the worker's uncertainty, stochastic programming is applied. In this research, an optimal workforce management model is developed to gain insight on how individual worker differences affect workforce planning and management decisions and to develop a quantitative decision tool that supports management of labor resource decisions.
(TF, Catalina)

Wirth, Patrick. University of St. Gallen, Switzerland
Vector Autoregressive Models in Multistage Stochastic Programming
The integration of vector autoregressive models (VAR) in multistage stochastic programs is investigated. VAR models are powerful instruments for modelling stochastic factors with their dependencies and relations. For the scenario generation with VAR models, the distributions of (multi step) forecasting errors are derived under different assumptions. The problem of managing savings account deposits is formulated as a multistage stochastic program and a VAR model is used for modelling interest rates and savings volumes.
(ThC, Catalina)

Wood, Kevin. Naval Postgraduate School
Delaying an Adversary in a Stochastic Network
We describe a simple model and solution procedures for this stochastic network-interdiction problem: Using limited resources, attack and destroy arcs in order to maximize the probability that the shortest-path length is greater than a specified threshold. Uncertainty arises because the interdictor does not know the exact topology of the network, is unsure what the arc lengths actually are or because interdiction of individual arcs may or may not be successful. Earlier work used Benders decomposition to solve this problem: We also use decomposition, but with a substantially tighter master problem that enables us to solve much larger problems. Furthermore, a new algorithm for generating near-shortest paths helps us generate master-problem constraints with great flexibility and efficiency. We present computational results using a new modeling system coupled with CPLEX.
(MC, South Ballroom)

· Held, Harald, University Duisberg-Essen
· Woodruff, David, University of California, Davis

Woodruff, David. UC Davis
Heuristics for Multi-stage Interdiction of Stochastic Networks
We describe and compare heuristic solution methods for a multi-stage stochastic network interdiction problem. The problem is to maximize the probability of sufficient disruption of the flow of information or goods in a network whose characteristics are not certain. In this formulation, interdiction subject to a budget constraint is followed by operation of the network, which is then followed by a second interdiction subject to a second budget constraint. Computational results demonstrate and compare the effectiveness of heuristic algorithms.
(MC, South Ballroom)

· Held, Harald, University Duisburg-Essen

Wortman, M.A.. Texas A&M University
Computational Probability for High-Stakes Wagering
High-stakes wagers can be characterized as one-and-out decisions having alternatives with which there is little or no direct historical experience. Typically the risks associated with these bets are large enough to require the introduction of utility functions that are not risk neutral. Under these circumstances, optimal wagering can be very computationally intensive. In this talk, we will examine certain computational methodologies that can be applied to order preferences among wager alternatives. Particular emphasis will

be given to random search procedures.
(TC, Catalina)

Zabarankin, Michael. Dept. of Mathematical Sciences, Stevens Institute of Technology
General Deviation Measures and Portfolio Analysis
The paper considers generalized measures of deviation in the framework of risk analysis and classical portfolio theory. Such measures, associated for example with conditional value-at-risk and its variants, can reflect the different attitudes of different classes of investors. Through techniques of convex analysis, the results deal rigorously with solution nonuniqueness and a potential lack of differentiability of the deviation expression with respect to the portfolio weights. Generalized one-fund theorems as well as covariance relations which resemble those commonly used in capital asset pricing models are derived. In aiming toward a more customized version of portfolio optimization, the results have broader significance than the classical ones, and they exhibit several features not previously encountered in this subject.
(MF, South Ballroom)

· Rockafellar, R. Tyrrell, Dept. of Mathematics, the University of Washington
· Uryasev, Stan, Department of Industrial and System Engineering, the University of Florida

Zakeri, Golbon. University of Auckland
Estimation of market distribution functions in electricity pool markets
The market distribution function is a probabilistic device that can be used to model the randomness in dispatch and clearing price that generators in electricity pool markets must take account of when submitting offers. We discuss techniques for estimating the market distribution function, and ways of measuring the quality of these estimators, using both classical statistical approaches and in the context of optimization.
(MF, Catalina)

Zhao, Lei. University of Arizona
Solution Validation in Multi-Stage Stochastic Linear Programs
Multi-stage stochastic linear programs can be extremely large, and are often solved only approximately based on a limited view of the problem data. We explore notions of solution quality in such problems. In particular, we will discuss possible upper and lower bounds that can be obtained by manipulating nonanticipativity constraints.
(ThF, South Ballroom)

· Higle, Julia L., University of Arizona

Zhu, Xiaomei. Virginia Tech
On Solving Discrete Two-Stage Stochastic Programs having Mixed-Integer First- and Second-Stage Variables
In this paper, we propose a decomposition based branch-and-bound (**DBAB**) algorithm for solving two-stage stochastic programs with fixed recourse and having mixed-integer first- and second-stage variables. A modified Benders' decomposition method is developed, where the Benders' subproblems are lower bounding functions in terms of the first-stage variables formed over a partial convex hull representation of the solution space that is sequentially generated using the Reformulation-Linearization Technique (RLT) or lift-and-project process. Valid inequalities are generated as functions of the first-stage variables that are reusable in the subsequent subproblems by updating the values of the first-stage variables. A branch-and-bound algorithm is designed based on a hyper-rectangular partitioning process, using the fact that the lower bounding Benders' master problem yields the same objective value as the original stochastic program if the first-stage variable solution is an extreme point of the defining hyperrectangle. We show that this algorithm converges to an optimal solution. Computational aspects of this approach will be discussed. Additionally, we apply this approach to a two-stage stochastic program for a flexible Fleet Assignment Problem in which the first stage problem contains pure binary variables and assigns aircraft families to flights, and the second stage problem contains mixed-integer variables and

assigns each flight with an aircraft type that belongs to the assigned family from the first stage (to preserve the crew schedule). This formulation thus yields an assignment of families to flights that minimizes the expected fleeting cost associated with fleet-type-assignments under a variety of demand scenarios, and serves to provide the desired flexibility for the later strategic re-fleeting process.
(TA, South Ballroom)

· Sherali, Hanif, Virginia Tech

Zhu, Yuntao. Department of Mathematics, Washington State University
Stochastic Semidefinite Programming: A Definition
Semidefinite programming is concerned with choosing a symmetric matrix to minimize a linear function subject to linear constraints, and an important additional constraint that requires the matrix to be positive semidefinite. We will refer to such a problem as a deterministic semidefinite program (DSDP) as the data defining such a problem is assumed to be known with certainty. DSDP's have been the focus of intense research during the past decade, especially in the context of interior point methods for optimization. DSDP's generalize (deterministic) linear programs (DLP). They have a wide variety of applications, especially beyond those covered by DLP's. There are efficient initerior point algorithms for solving DSDP's.

Stochastic programs have been studied since the sixties as optimization models to handle uncertainty in deterministic optimization problems. In particular, (two-stage) stochastic linear programs (SLP) could be thought of as a way of handling the uncertainty in DLP's. SLP's have many important applications and there are efficient algorithms (both interior point and noninterior point) algorithms for solving them.

The purpose of this paper is to define an optimization problem which we refer to as a stochastic semidefinite program (SSDP). SSDP's are related to DSDP's in the same manner as SLP's are related to DLP's. We also comment on applications of and algorithms for SSDP's.
(TA, Rincon)

· Ariyawansa, K. A., Department of Mathematics, Washington State University

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